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S. D. KIRKPATRICK, Editor

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Are You Overstocked In Brains Too?

"WE ARE NOT taking on any new men this year." "We have reduced our technical personnel to a skeleton organization of key men and do not expect to fill it out until business warrants an expansion." Such pronouncements have a familiar ring to a great many employers and to the bewildered and slightly discouraged youngsters whose inquiries have prompted them. As an opportunistic measure they undoubtedly are effective. But are we justified in accepting this way out of the present situation?

MEANWHILE, for the first time in a decade chemical engineering graduates of leading colleges and universities are looking in vain for jobs. A year ago all the six-year men in one prominent institution were placed in industrial positions by February or March—some of them receiving a half dozen attractive offers. This year only one of this particular group has secured a position. In former times, the representatives from a dozen industries have visited this department, but this year only two came—one from a rubber company and another from a rapidly growing heavy-chemical industry. Neither was able to offer immediate employment. At another Eastern school the only chemists and engineers to get jobs are those who have family connections. Of eight four-year men in one graduating class, seven are returning for graduate work—a wise decision under present circumstances, but certainly not a final answer to the industrial problem.

INDUSTRY has an opportunity to take the pick of these men—if necessary, at its own price. There need be no questioning of the real values involved. The fact that technical man power is cheap today does not mean that it will not be worth more tomorrow. The 1931 graduate wants only the chance to get started, leaving the future to determine whether or not he can make himself an indispensable part of the organization.

THIS BUILDING for the future comes at a time when the best building materials are available at the lowest prices in history. But price is not the determining factor in this transaction. Salaries are not, by any means, the largest item in the budgets of most technical departments. Overhead and the cost of supervision continue even in a skeleton organization. The prime consideration is the output of new ideas for production or sales development, many of which will come from new blood.

WHAT COMPANY today has a surplus of brain power and a dearth of manufacturing facilities? Many have used the depression to expand their plants and laboratories, forgetting that the single most important element is the knowledge and experience that comes only from a well-integrated and carefully trained personnel. Despite the attraction of the security and commodity markets, it is our judgment that there is no better investment today than in the cream of the 1931 crop of chemical engineers.

EDITORIALS

JUNE, 1931

The Missing Element In Business Recovery

SOMETHING else is needed in business today. New ideas and products, plants and processes are not enough. Lammot duPont, in his short poignant message to the Manufacturing Chemists' Association, emphasized an old-fashioned doctrine that has been sadly neglected of late. He pleaded for confidence, trust, and respect for our fellow men, whether competitors or customers. Those disastrous price wars, he said, would not have occurred if the men responsible had acted like normal human beings should. Distrust and suspicion lead to retaliation and underhanded dealings. Perhaps it is time to dust off the Golden Rule and substitute it for those dismal charts of declining prices and disappearing profits.

An Opportunity For Constructive Service

ANY occasion is worth while that brings together the metallurgist and the chemical engineer to talk over their common interest and concern in new materials to resist the ever increasing temperatures and pressures met in the process industries. Unfortunately, some of these meetings of late have failed to accomplish their major purpose, because of the lack of a more cooperative spirit between the two groups. Divided opinion and acrimonious dispute within the ranks of both parties have only confused the prospective user who required exact information on the properties and performance of metals and alloys.

The forthcoming joint meeting of the American Society for Testing Materials and the American Society of Mechanical Engineers, to be held in Chicago during the week of June 22, offers an unusual opportunity for service to chemical engineering. Its program, dealing first with the needs of the various industries and then with the properties of available metals at high and low temperatures is well provided with talent and authority. It is hoped, therefore, that those in charge will direct the debate and discussion to yield a maximum of constructive information and a minimum of controversy and confusion.

Casein Tariff Proves a Boomerang

FOREIGN repercussions of the Hawley-Smoot tariff are still claiming space on the front pages of the daily press, but less attention is being given to some of the domestic difficulties directly traceable to this debatable legislation. Casein is a case in point, for the effect of the increased duty seems to have been exactly the opposite to that predicted by its proponents. The facts are worth pondering, especially in their relation to other process industries.

The manufacture of casein happens to be a business that a man can get into and out of almost overnight, and with very little capital expenditure. The price of the product before the tariff was enacted was around 14 or 15 cents a pound and there was a rather healthy demand for it from both foreign and domestic sources. However, when it became evident that the tariff was to be raised from 2½ to 5½ cents, most of the large users greatly increased their stocks of the imported material. About this time, too, the Department of Agriculture began to advise the different dairy industries of the good market that the tariff would soon protect for the American producer. Consequently small casein plants started up in various parts of the country, with the result that very shortly domestic production was in excess of any normal demand, let alone the somewhat curtailed requirements of today. And so casein is now being offered at 7½ cents—or just half of pre-tariff quotations—and we hear that there is much that cannot be sold at even 5 or 6 cents.

With growing inventories and a slow market, some of the large and more progressive manufacturers are now concentrating on research as a possible way out of their difficulties. Several new uses of fair promise have already been developed through this intensive effort. But the fact remains that instead of saving the farmer $2,500,000 annually, as was claimed for the increased tariff, it has actually proved the source of an even larger loss to both industry and agriculture.

S. W. Parr, 1857-1931

THIRTY-FIVE years of active, inspiring teaching of applied chemistry in an American institution is no mean record. Add to it the same number of years spent simultaneously in chemical and engineering research on coal, gas, shale, and other resources of a great state. Credit it with the invention and commercial exploitation of a dozen useful tools for the calorimetry and analysis of fuels, a series of acidproof alloys, and, finally, with the successful large-scale demonstration of a process for the carbonization of non-coking coal. Honor it with many professional responsibilities and important offices. Surely such is a career on which any man could look back with the pride of achievement—perhaps content to spend the glorious twilight of life among old friends and admiring associates. But no such course suited the commanding character of Samuel Wilson Parr.

In 1926, when a new ruling of the University of Illinois forced him to retire from active teaching because he had reached the age limit of 69 years, Professor Parr really began to live. It gave him the chance to complete some unfinished researches. He had more time for his personal business and, with the willing support of an old and true friend, he formed the Burgess-Parr Company to further the development of his calorimeter and alloys and also The Urbana Coke Company to demonstrate his carbonization process. He even accepted from the hands of his former colleague, President Charles Russ Richards of Lehigh University, an honorary doctorate of science—one of those frills he somehow never found time to acquire through academic pursuit. In 1926 Columbia University awarded him the Chandler gold medal "in recognition of distinguished achievement in chemical service." In 1928 he served with distinction as president

of the American Chemical Society, having already been a director and a member of its executive committee.

He continued his great scientific interest in coal, in fact helped sponsor and actively worked with an associate in the preparation of a paper for the Mid-West Coal Conference held in Urbana but a few days after his death. While still confined to bed as a result of his last illness, Professor Parr devoted much of his time to a revision of his widely used text book "Fuels, Gas, Water, and Lubricants." He had almost finished its preparation for the printer when the fatal heart attack brought his life to its sudden close.

Crowding such a record as this into these last five years has rounded out a truly remarkable professional career. And yet the thousands of American chemists and engineers who were proud to call Professor Parr their friend will always remember him primarily as an intensely human being. He inspired their admiration and respect for his strong character and high ideals. He won their love and affection with his sympathetic, kindly counsel. His passing leaves a void in their hearts, yet the memory of a full life that many will cherish as an ideal.

A Convergence Of Parallel Forces

CHEMICAL engineering owes much to metallurgy. Such unit operations as crushing and grinding and roasting and calcining were largely handed down to us from pyrometallurgical practice. In the case of hydrometallurgy, more specifically the cyanide process, the debt is even more impressive. Dissolving and leaching, mixing and agitation, sedimentation and thickening, screening, classifying, and filtration, are all included. And more important than the engineering are the engineers, many of whom are today the recognized leaders of our profession. Their names, inseparably linked with the equipment of their creation—Dorr thickeners, classifiers, and agitators; Oliver filters; Sweetland and Kelley presses—have become a part of the accepted language of chemical engineering.

Behind these names are rich personalities as well as long and interesting careers. In the case, for example, of John Van Nostrand Dorr and Edward Letts Oliver we find two men whose lives and work have been strangely similar—paralleling, yet seldom duplicating each other in their closely related activities. Now comes the announcement that these parallel forces are to converge in the formation of the Dorr-Oliver Corporation. The two component companies continue the businesses which they have individually built up to serve their complementary, rather than competitive, fields. But in this converging process there is a pooling of technical experience, research, and developmental facilities that holds out the promise of further improvement in the equipment and processes that these men and their companies have contributed to industry. Thus chemical engineering will continue to benefit from its metallurgical inheritance.

A Threatened Extension Of Governmental Regulation

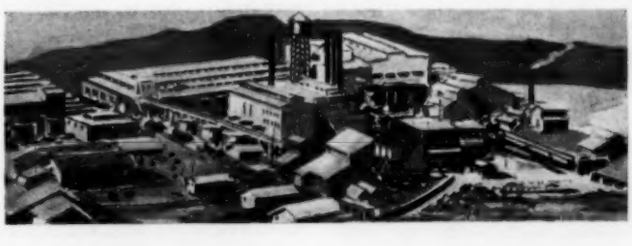
OCCASIONALLY there crop up in state and federal legislative halls, measures evolved and sponsored in good faith which, if enacted into laws, would place heavy burdens upon legitimate business. Drafted by a professor of applied physiology at Yale University and awaiting introduction in the next Congress by the senior senator of Connecticut is a bill which proposes drastic legislation affecting an important branch of the chemical industry. Going far beyond the federal Caustic Poisons Act, this bill provides for the regulation of the sale of all poisonous volatile substances under a criminal statute. The author cites instances where the use of such chemicals as methanol, benzol, and methyl chloride subjected the public to serious hazards to life and health. The proposed bill, therefore, is based on humanitarian grounds.

The measure would place the sale of poisonous volatile substances under the jurisdiction of the Secretary of Agriculture. Shipments would be controlled by a permit system which involves special label requirements. Violations are made punishable by fine or imprisonment, as well as confiscation of the goods in question. The bill also provides for compensation if personal injury is incurred as a result of violation. In the light of experience in recent years with conditions surrounding the sale of industrial alcohol, members of the solvent industry may well be stirred into defensive action by the possibility of even more drastic legislation affecting their own interests.

Look for the Silver Lining

WITH the price of silver still slipping and scarcely due for an appreciable increase, chemical engineers interested in new materials for the construction of equipment can well afford to investigate the more extensive use of this metal and its alloys in industry. Some of the mechanical properties of silver are attractive for low-temperature use. It possesses great malleability and ductility, and therefore is easy to work. The metal can be joined by autogenous welding and the joint made as strong mechanically as any other part of the vessel. The melting point, on the other hand, is only about 950 deg. C. Silver and its alloys are available in sheet, rod, wire, tubing, and castings of various sizes.

This metal is not a stranger to the process industries. It is already used in lining vacuum pans in tannin-extract plants; in pharmaceutical manufacturing it has been adopted for phenol still linings, containers, and tubing. Probably its most important application has been in acetic acid and anhydride plants. These installations were made when the price was much higher. At something like 27 cents an ounce and with a comparatively high salvage value, silver can scarcely be regarded as an expensive construction material.



How Fisheries Enlist Chemical
To Rationalize an Ancient

By CLARENCE BIRDSEYE

Vice-President, General Seafoods Corp., Gloucester, Mass.

NEW ENGLAND has been renowned for her variety and abundance of fish and fishery products ever since the landing of the Pilgrims. The Pilgrim Fathers had difficulty in obtaining sufficiently large crops on the rocky soil of New England and might have starved if it had not been for the bountiful supply of sea food close at hand. Fish, lobsters, crabs, mussels, scallops, and clams were very plentiful. Oysters were easy to get almost anywhere from Rhode Island southward. The proximity of the banks, where cod and other ground fish were so plentiful, encouraged the building of sailing vessels. Yankee ingenuity invented the schooner, and soon America became an important maritime nation. The people of Massachusetts have recognized their debt to the cod and have hung a model of it in the hall of the House of Representatives. Formerly the importance of Massachusetts fisheries was officially recognized by the emblem of the cod on motor vehicle licenses.

Taken as a whole, the fisheries and fishery industries of New England now employ 25,000 persons who produce on the average 400,000,000 lb. of edible varieties whose wholesale value is about $30,000,000. Massachusetts produces approximately half of this total. The canning of sardines is the most important fishery industry, yielding about $7,000,000 worth of canned fish. This industry is centered in Eastport, Me. Fish glue and fish meal are the two most important byproduct industries. There are produced approximately 600,000 gal. of glue, valued, wholesale, at more than $600,000.

In former years the cod was the most important fish landed in New England. It is still among the most important fishes, for about 50,000,000 lb. is landed in Boston each year. With the introduction of the steam trawlers which sweep the bottom of the banks and consequently catch bottom-feeding fish, haddock gradually put cod into second place in importance. Today approximately three times as much haddock as cod is landed in Boston.

Preservation of Fishing Gear

New England fishermen use a large number of nets, seines, traps, and trawl nets. This equipment, and the vessels from which it is used, require vast quantities of netting, lines, ropes, cables, and other forms of cordage. The statistics collected by the U. S. Bureau of Fisheries indicate that more than 11,000 gill nets, 1,000 trawl nets, 300,000 lobster pots, 4,000 scallop dredges, and thousands of units of other types of gear employing netting are in nearly constant use in these fisheries. Over 5,000,000 baited hooks attached to lines are employed. Most of this equipment has an exceedingly short life, so one of the major problems is the preservation of nets and lines.

When the value of the cordage gear used by the New England fishermen—$4,000,000— is compared with the value of the annual catch of fish and shellfish, which is about $25,000,000, it is seen that the length of life of the gear is a very important factor in the cost of catching sea foods; especially when one considers that many nets wear out in one season, and most nets last less than two seasons.

Until 1919 no scientific investigation of chemical preservatives for nets, twines, and ropes had been carried out in this country. In that year the U. S. Bureau of Fisheries began a comprehensive study of means of lengthening the period of usefulness of these important tools of the fisherman. These investigations, which are still being continued, have brought to light an important new preservative for nets and twines, copper oleate. This chemical, when used in combination with coal tar, has been demonstrated to be a most excellent preservative of tensile strength of cordage gear. Treated with this combination of preservatives, netting often lasts twice as long as that treated with proprietary preservatives. This problem is worthy of further study, and several very promising materials are at present undergoing exhaustive tests under practical conditions.

Presented before the meeting of the American Institute of Chemical Engineers at Swampscott, Mass., on June 12, 1931.

Engineering Industry

Docking Fish at General Seafoods, Inc. Gloucester, Mass.

Salt Preservation Difficulties

Prior to the introduction of ice and other means of refrigeration in the fishing industry, the fish had to be salted or otherwise preserved very soon after capture. For this reason the salt-fish industry was the most important of the marine fisheries until the latter part of the nineteenth century. When the use of ice for preservation of fish during transportation became common, the relative importance of salt fish began to decline, and is today entirely overshadowed by the fresh and frozen fish trades. However, even now the value of the salted fish prepared annually in New England is about $2,500,000.

This ancient industry has several problems requiring the services of bacteriologists and chemists, and chemical and sanitary engineers. Salted fish, especially cod and haddock, turn red during warm weather unless certain precautions are taken. The cause of this reddening was a deep mystery until the bacteriologists demonstrated that the red color was caused by colonies of pink *spirochaetes* and red bacilli. Further study indicated that these same red bacteria flourish in the solar salines, or ponds, in which salt is manufactured from sea water, and that the salt produced in these salines was so full of these bacteria that in large piles it was slightly pinkish in color. The storerooms in which the salt was kept in the fish-salting plants were found to be badly infected, as were also the wharves, tables, tubs, and butts in which the fish were prepared. Grainer salt, vacuum pan salt, and mined salt were shown to be free from the reddening organisms.

The storage of the salted fish in cool or cold rooms prevented the loss of the product prior to shipment. However, this did not eliminate the objectionable reddening while on the retailers' shelves. Antiseptics, such as sodium benzoate and boric acid, lessened the danger, but these are frowned upon in some states by the food and drug authorities.

The logical procedure was to clean up and disinfect the fish salting plants and then discontinue the use of the badly infected solar salt. Some manufacturers have cleaned up their plants and have experimented with the use of mined, grained, and vacuum pan salt; but most fish salters still prefer to use solar salt as they have not been able to duplicate their product using domestic salts.

Here is an important problem for the research chemist and chemical engineer, as the character of the salted fish produced varies not only with the chemical composition (calcium and magnesium content) of the salt but with the size of the grains. Further investigation needs to be carried out before the customary quality of salted fish can be produced by the use of domestic salts.

Early Refrigeration Methods

After the first successful long-distance shipment of fish packed in ice in 1858, the fish business expanded rapidly as shipment in ice became a universal practice. Fish had now been taken out of the ultra-perishable class; yet, except in the winter months, shipments beyond 300 or 400 miles were rare. When the railroads and express companies provided more rapid transportation facilities and re-icing service, the distance a shipment could be made was doubled. However, the markets near at hand absorbed the greater part of the production. Until recent years, a shipment as far west as St. Louis was rare even in the winter. A revolutionary forward step in the history of the fish business began when radical improvements in methods of merchandising fish were brought forward and when the use of mechanical refrigeration became general.

The most important contribution of engineering to the New England fisheries has been the rapid advance made in the application of mechanical refrigeration since the latter part of the nineteenth century. It was soon learned that the use of mechanical refrigeration for the preservation of fish made possible the smoothing out of the gluts caused by the excessively large catches of fish at certain seasons and the scarcity of catches at others.

The fishing industry has been one of the leaders in the freezing of food products. As far back as 1861, Enoch Piper received a United States patent for freezing fish in salt and ice. Numerous such methods were used on a small scale until 1892, when the first ammonia refrigerating machine was introduced. Since then, and particularly since the beginning of the present century, the freezing of fish in cold rooms (sharp-freezing or slow-freezing) has come into widespread use. Many millions of pounds of fish are so frozen each year in New England today.

Brine freezing was suggested in 1889, when two different English patents were granted for freezing in a cold brine made from salt and ice. Its advantages were not fully realized in the United States until about 1919, when it was demonstrated that quick-freezing produces

better frozen fish than sharp-freezing does. Davis, in 1875, patented a method of freezing by indirect contact capable of producing a very good grade of frozen product. This method is still used extensively in the Great Lakes region.

Introduction of Filleting

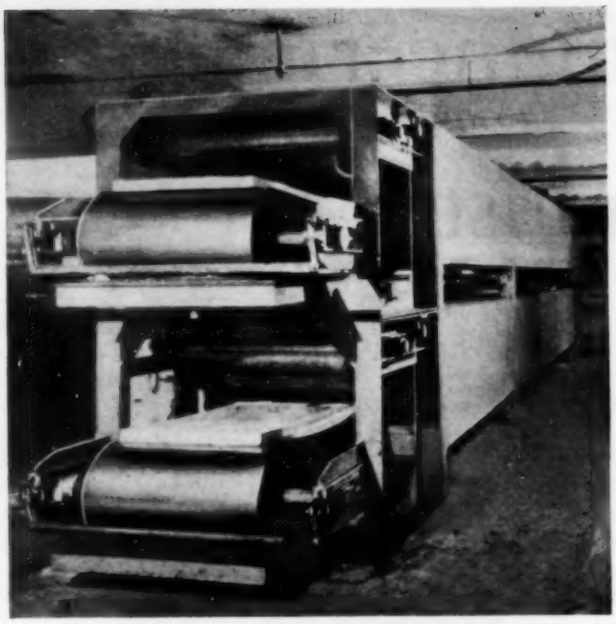
About 1919, Kenneth Fowler, of New York, started an experiment which was the forerunner of a series of developments which have revolutionized the entire fishing industry. He conceived the idea of dressing fish ready to cook (as fillets, pan fish, or steaks), wrapping them separately or in small bundles, chilling them to just above the freezing point, and shipping in returnable heat-insulated, balsa wood boxes, without ice, direct to the retailer. Fowler realized the necessity for sanitary handling, and for preservation relied largely upon cleanliness and low—but not freezing—temperatures. He washed his dressed fish in clean sea water, but used neither fresh water nor brine at any point in direct contact with his product. For several reasons Fowler's undertaking was not a financial success.

In 1921, Dana Ward, a Boston fish merchant, developed an entirely different method of shipping dressed fish. He brined his dressed fillets or pan fish for a quarter of an hour or more in an 80 to 100 per cent saturated brine and wrapped the individual pieces in vegetable parchment paper. At first he shipped the product in uniced wooden boxes. Later he lightened the brining, and shipped in tin cans—either dish-shaped or rectangular—surrounded by crushed ice in wooden packing cases. This method quickly spread throughout the North Atlantic seaboard, from New York to Nova Scotia, and is still in extensive use. It was one of the commercial forerunners of packaged flesh foods.

Introduction of Quick-Freezing

The original quick-freezing process, by immersion in very cold brine, is not adaptable to fillets, inasmuch as they have a large area of flesh surface exposed to the brine and absorb too much salt during the freezing process. Therefore it was necessary to find some means of quick-freezing fillets without having them come in direct contact with the brine. Davis, Cooke, Kolbe, and the author patented methods and apparatus for quick-freezing fillets singly or in blocks. None of these methods was successful for freezing fish in consumer packages, and, recognizing the many substantial advantages of packaging first and quick-freezing afterward, the author developed and patented the so-called "Double-Belt Froster," shown in the accompanying illustration.

The product to be frozen is fed onto the receiving end of the lower of two flexible non-corroding Monel metal belts which pass into an insulated freezing tunnel. The two belts grip the product firmly while it is in transit and relinquish it automatically at the delivery end of the apparatus. The pressure of the upper belt is controlled so that an article of any height up to the distance between the pulleys carrying the belts can be put through the machine and the same pressure applied to all thicknesses. The width of the product is limited only by the width of the belts. While the product is going through the tunnel, calcium chloride brine at approximately 45 deg. F. below zero is sprayed on the upper side of the top belt and the lower side of the bottom belt, thus assuring the rapid extraction of heat from the product through the belt. There is, furthermore, an automatic device to keep the brine from penetrating between the belts and coming in contact with the product. Freezing



Birdseye Double-Deck, Double-Belt Quick-Freezing Tunnel

may be done continuously or in batches. At the delivery end of the apparatus the frozen material moves out of the machine and is carried off to the packing room.

After a long period of experimentation the development department of the General Seafoods Corp. has perfected a quick-freezing apparatus which is a modification of the double-belt quick-freezing machine and covers adequately certain fields for which that machine was not particularly designed. The new apparatus is known as the multi-plate froster. While having similar elasticity and simplicity of operation, and utilizing the same direct-contact and controlled-pressure principles originally worked out and patented in connection with the double-belt machine, the multi-plate apparatus is an all-purpose machine valuable for both small- and large-scale production, and will handle equally well either packaged or bulk products.

Storage and Transportation

But proper quick-freezing alone will not insure the successful distribution of frozen sea foods, for most such products are either seasonable or must be shipped long distances before reaching the ultimate consumer. Let us consider, first, the problems underlying prolonged cold storage.

Desiccation, of course, is one of the most serious causes of deterioration, and is due to the passage of moisture-vapor from the product through the air to the refrigerating medium. Desiccation causes serious shrinkage, ruins the appearance of the product, and adversely affects its flavor. Oxidation is another serious factor which must be rigidly controlled. It is brought about both by enzymic action and hydrolysis. The higher the storage temperature and the greater the quantity of air having free access to the product, the more rapid oxidation will be. Oxidation may manifest itself in numerous ways, among which rancidity, color changes, and the development of a "salt-fishy" odor and flavor are most frequent.

The only entirely safe way to distribute quick-frozen perishables is to make sure that they remain hard-frozen until they reach the consumer. Such foods contain within themselves a large amount of refrigeration, and if

placed in well-insulated shipping containers may be transported for long distances even by ordinary express or parcel post. For this purpose corrugated fiberboard containers (shown in illustration), with the proper number of pads and liners, are admirable. Corrugated fiberboard has about the same insulating value as good sheet cork, and is light, strong, and inexpensive. Such a container will stand shipment by express and if solidly full, will, even in the hottest weather, keep its contents frozen for from three to five days—and perfectly fresh, although partially thawed, for a much longer period.

The outstanding economy of filleting is the reduction of shipping weight by elimination of the waste portions of the fish at the point of production. This amounts on the average to at least 55 per cent, and in the case of flat fish may be as high as 75 per cent. The outstanding economy of quick-freezing is that the product is rendered practically imperishable, thus largely ironing out the irregularities of supply and demand, and tending to stabilize prices. Distant markets have been made available, as evidenced by the fact that the center of distribution of the fish produced at our Gloucester plant is approximately 1,200 miles from Boston.

The quick-frozen fillet has placed the New England fishing industry on a high business plane. Packing-house methods are now employed. The business is gradually becoming amalgamated into larger units where all the economies of large-scale production can be reaped. Even the relatively small wholesalers have increased their efficiency by improving their production layout and by including labor-saving equipment such as mechanical hoists, conveyors, and packaging machinery. For those who cannot afford to own their own quick-freezing equipment, public cold storages have provided this facility at a reasonable charge.

Sanitation in Plants

When handled, packed, and frozen by the old methods, the bacterial count of the fish, gradually increased as it passed through the plant. In a sanitary modern plant, bacterial contamination is held at a minimum and the finished product passes into consumption with a "count" as low as that of good Grade "A" milk. In the plant of the General Seafoods Corp. this is brought about in the following manner.

When the fishing vessel arrives at the plant, the fish are thrown by hand into 100-lb. canvas baskets and hoisted out of the hold, and then dumped into a wash tank of running chlorinated sea water. This washing removes much of the slime, ice, and other extraneous matter, and reduces by at least 75 per cent the total bacterial count on the outside of the fish.

From the wash tank the fish are carried by an automatic conveyor across a culling table, and deposited in a wooden box, in one side of which is a hinged door. Six hundred pounds of fish is placed in each box. A layer of crushed ice is placed on the bottom of the box, another is placed in the center of the mass of fish, and a final layer is added when the box is filled. The iced boxes of fish are immediately hauled to a refrigerated room, held at 36 deg. F., at the receiving end of the plant, where they are held sometimes as long as 48 hr.—never longer—awaiting filleting.

If the fish are to be scaled, the boxes of iced fish are removed from the cold room and their contents dumped into the hopper of the scaling machine, where the scales are removed under a spray of chlorinated sea water. The fish are then automatically conveyed through a washing tank, through which chlorinated sea water is flowing, and then to the cutting tables, where the fillets are removed by skilled workers.

If the fillets are to be skinned they pass to the skinning machines, which operate under a spray of chlorinated sea water. The skinned fillets are then carried over an inspection conveyor which passes the selected fillets into the brining machine, where they are immersed for about 17 sec. in a weak sodium chloride brine, containing a small amount of sodium hypochlorite.

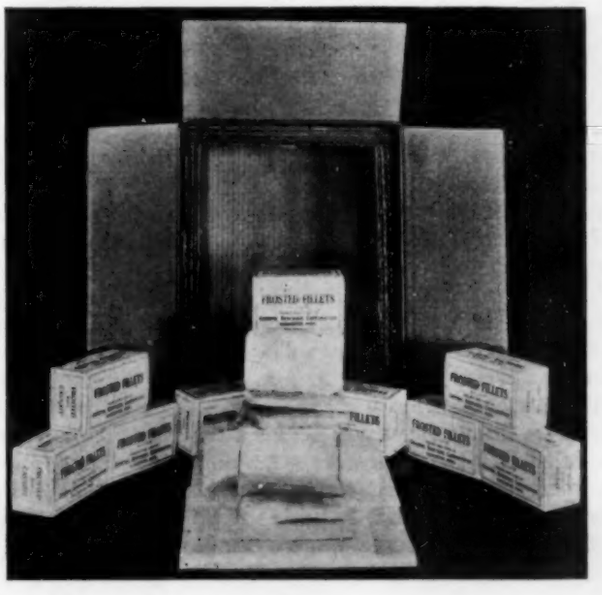
The brined fillets are placed in Monel metal pans and conveyed to the Monel-topped packing tables, where they are weighed, individually trademarked, wrapped in moisture-proof Cellophane, and packed in cold-waxed cartons. The packaged fillets are then quickly frozen in the "Double-Belt" apparatus. The frozen fillets are placed in cold storage at a temperature of about —10 deg. F.

The water used in washing the fish, tables, machinery, etc., is sea water taken from the outer harbor and chlorinated to about seven parts per million on the suction side of the pump. A portion of this chlorine is used up in oxidizing the organic matter in the water, so that by the time the water reaches the 10,000-gal. tank in the tower of the factory the free chlorine content is only about five parts per million. The pumps are operated continuously day and night, thus insuring a freshly chlorinated supply of nearly sterile sea water at all times. In passing from the large tank to the wash tank on the receiving wharf and the several machines on the dressing floor, the content of free chlorine drops from 5 to 1-3 parts per million.

This chlorinated sea water is used not only to wash the fish on the receiving wharf and just prior to filleting but is also sprayed on the fillets just before they enter the brining machine so as to lessen contamination of the brine. The salt brine itself is treated hourly with a measured quantity of sodium hypochlorite, so that it constantly contains from one to three parts per million of active chlorine.

In order to keep a careful check on the quality of raw material used, all important information relative to the purchase and production of each lot of fillets is recorded. In addition, two samples taken at random from each lot

Long-Distance Shipping Container for Frozen Fish Fillets



are put through bacteriological, leakage, and cooking tests. All these data are entered on a Lot History Sheet, which must be approved by a responsible member of the laboratory organization before any part of the production covered is released for shipment.

These many precautions insure the production of fillets of extremely low bacterial content and uniform general excellence. The product from such a plant is sold on a quality basis, and readily commands a substantial price premium.

Exploiting Filleting Wastes

In the case of the haddock filleting industry, the yield of fillets from an already eviscerated fish is only approximately 40 per cent. The remaining 60 per cent—backbone, skin, head, scales, fins—is utilized for the manufacture of fish meal, glue, and other byproducts. Formerly, when fish were retailed undressed, this valuable material was not only a total loss but before being eliminated and thrown away was often at great cost transported several hundred miles from the seaboard. Now this waste is eliminated in large quantities at the dressing plants, and utilized for a very high grade of byproducts, which enjoy a ready market.

When cooked with steam for several hours the bones and skin of haddock and other members of the codfish family are converted into liquid glue. The glue liquor is drained off and the cooked fish pressed to obtain still more liquor. The combined glue liquors are then filtered and evaporated by means of copper steam coils revolving in open tanks. The pressed cooked scrap is dried, preferably in steam-jacketed vacuum dryers.

Another important byproduct of the New England fisheries is cod-liver and, of late, haddock-liver oil. The demand for both medicinal and feeding oil has greatly increased in recent years, and many fishermen who formerly discarded the livers are saving them or are rendering them into oil. A small, simple steam rendering apparatus has been perfected which makes the production of high-grade oil on shipboard a simple matter.

Unsolved Problems

In spite of recent progress in New England's fisheries, numerous vital problems remain unsolved. Many of these are chemical, others mechanical. Most of them arise from the fact that quick-freezing has so increased the demand for North Atlantic sea foods that future supplies will have to be drawn from fishing grounds too remote for profitable development by present methods. Self-propelled, seaworthy floating factories, acting as mother ships for smaller fishing craft and performing within themselves all dressing, packaging, and freezing operations, will be necessary. The entire catch of the nets and lines will have to be utilized for useful purposes—at least 33⅓ per cent of the present-day trawlers' catch is returned, dead, to the water! Artificial propagation must be applied more extensively, and kinds and sizes of fishing gear effectively regulated so as to protect immature fish.

In short, the fish industry of the future will, like other modern businesses, be based increasingly upon scientific research; and progress will be dependent upon the success with which chemical engineering problems are conceived and solved.

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Mechanism of Leather Manufacture

By W. K. LEWIS and R. H. W. LORD

Respectively Professor of Chemical Engineering Massachusetts Institute of Technology and President, Lord Tanning Co., Woburn, Mass.

RECENT DECADES have brought striking changes in the methods of leather manufacture as well as in the knowledge of the nature both of the hides and the processes involved in leather manufacture. Raw hide is made up of a natural fabric of interwoven fibers consisting of proteins very sensitive to water, and subject to putrefaction. The tanner's problems involve the removal of hair, dirt, and blood, after which the sensitivity to water and the ease of putrefaction must be reduced by chemical means—tanning—and this is followed by a series of finishing operations to give desired mechanical and other characteristics.

Hair is removed by treatment in lime pits, followed by scraping, or by the action of sodium sulphide. After mechanical removal of adhering flesh, further treatment depends largely on whether the object is the production of heavy or light leather. For heavy leather, the process involves filling the spaces between the fibers more or less completely, by depositing tanning material. Light leathers, however, require a minimum of filling. For heavy leather the first step is to wash out the lime, after which it is neutralized and the hide plumped with acid. This is followed by progressively stronger baths of tan liquor, thus depositing tannins in the voids. After partial removal of the excess surface deposit of tannins, a certain quantity of oil or grease is introduced into the leather, by treating with a water emulsion of oil or fat, or with the oil or fat directly. This prevents amalgamation of the fibers during subsequent drying and promotes flexibility.

In making light leathers the object is to avoid filling the spaces between the fibers. It may even involve destroying a small part of the fiber, using old lime solutions or digestive enzymes. In order to avoid plumping in the acidic chrome bath usually required by light leathers, the hide is pickled in a solution of dilute sulphuric acid and salt. It is then treated with water solutions of trivalent chromium, which change the characteristics of the leather only slightly, except that on dehydration the affinity for water disappears. As in the case of heavy leather, it is again necessary to prevent the coalescence of the fibers on drying by a treatment with fat or oil. For special purposes, other tanning materials are sometimes used for light leathers.

Leather's engineering uses are confined chiefly to belting, diaphragms for gas meters, packing for certain pumps, fabric for polishing, and as a straining and filtering medium. Its former extensive use as raw hide in pinions is being lessened by competition from vulcanized fiber and similar materials. Leather has as limitations its lack of resistance to acids and alkalis and its sensitivity to stretching with increase in moisture content. Under tension it has an elongation proportional to the square root of the load. On this account there is little elongation of leather belts once they have been properly broken in.

Abstract of a paper presented before the American Institute of Chemical Engineers at Swampscott, Mass., June 11, 1931.

Chemical Engineers Study Theory of Heat Transfer

EDITORIAL STAFF REPORT

TWO EXTENDED SERIES of studies of the more theoretical aspects of heat transmission were summarized in papers presented at the Swampscott meeting of the American Institute of Chemical Engineers on June 10 and 11. The first of these was from the chemical engineering department of Massachusetts Institute of Technology, representing work done there under the direction of Profs. W. H. McAdams and W. P. Ryan by Thomas B. Drew and J. J. Hogan.

Theoretical equations for the transfer of sensible heat by conduction in fluids flowing in streamline motion inside heated or cooled pipes were discussed in a paper by Drew, Hogan, and McAdams. They summarized their discussion as follows:

In heating a hydrocarbon oil flowing in streamline motion inside a steam-heated horizontal pipe having a diameter of approximately 5 ft., the oil leaving the heated section was mixed before measuring the average temperature, and heat balances agreed within 10 per cent. The weight rate of flow varied 2,300-fold. The Reynolds number, based on the average temperature of the oil, varied from 2 to 1,200 in consistent units. The data, when plotted as required by theory, with ratio of temperature rise to effective temperature difference versus the dimensionless group of factors Wc/kL, involving weight rate, W; specific heat, c; thermal conductivity, k; and heated length, L, give a smooth curve of the shape required by theory. However, for a given Wc/kL, the empirical curve calls for substantially greater heating than the theory based on the parabolic distribution of mass velocity.

In the literature some data are available for the heating or cooling of oils or water flowing in streamline motion under horizontal pipes. While in general these data from the literature are incomplete with respect to heat balances or proper precautions for the measurement of average temperature of the heated or cooled fluid, yet, because of the scarcity of data, these are plotted and compared with the data of this investigation. In general, the data of the literature are not as consistent, but give results of the same order of magnitude as the new data. Few cooling runs are available, and these fall below the heating data.

In addition to the plots mentioned above, all data are replotted with the same ordinates, versus the Reynolds number, instead of the group Wc/kL. Where inlet temperature and pipe-wall temperature were approximately constant, the results for any one fluid in a given apparatus are fairly consistent. However, a comparison of all the data shows no correlation of rise/effective temperature difference in terms of the Reynolds number, which involves viscosity, thus showing that for streamline flow the use of the coordinate Wc/kL is preferable to the more popular Reynolds number.

To emphasize the importance of the use of a device to mix the heated oil before measuring its average temperature, the authors presented data which show that the apparent rise in oil temperature, based on the reading of a thermometer placed at the center line near the exit from the heated section, in certain ranges of conditions would give errors as high as 1,000 per cent and these findings are substantiated by heat balances checking within 10 per cent.

A program of research has been undertaken by T. B. Drew and W. P. Ryan in order to elucidate the mechanism of heat transmission, which is at present incompletely described by the "film theory" commonly given in textbooks. Their paper reviewed the published data on the temperature and velocity distribution in the fluid near a cylinder both for isothermal conditions and during forced convection. The nature of the velocity distribution is found to be well understood for the isothermal case, but very little is known about it when conditions are non-isothermal.

A third paper in the M.I.T. series by Mr. Drew, was entitled "Mathematical Attacks on Forced Convection Problems." This presented the principal published solutions of the Fourier-Poisson differential equation for heat convection in moving media.

The second series of studies was concerned with heat transfer and pressure drop in empty, baffled and packed tubes, and was presented in three papers by Allan P. Colburn; Thomas H. Chilton of the du Pont Company; and W. Julian King, of General Electric. The three discussions are summarized by the authors below:

Heat Transfer in Packed Tubes—Coefficients of heat transfer to air flowing through a tube filled with granular materials were determined experimentally to be about eight times as high as would be expected for the same gas rate through the empty tubes. The coefficients were found to vary with the mass velocity of the gas raised to the 0.83 power and with a function of the ratio of particle diameter to container diameter.

Pressure Drop in Packed Tubes—Experimental data on the pressure drop through various types of solid packing materials were determined concurrently with heat-transfer studies. These data were correlated with the reliable data from the literature to give the friction factor plot, which presents a general method of predicting pressure drops in both the viscous and turbulent regions. It is shown that a large share of the pressure drop may be due to expansion and contraction losses. Data on hollow and on wet packing materials are given.

Heat Transfer and Pressure Drop—For turbulent flow of gases in empty tubes, heat-transfer coefficients vary with the 0.44 power of pressure drop as the velocity is increased. The introduction of baffles or packing into a tube increases the heat transfer to a somewhat less extent than the 0.44 power of pressure drop, but in a regular manner. From the curves given it seems possible that the heat transfer coefficients for almost any type of baffle or packing can be estimated if the pressure drop is determined.

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The Continuous Centrifugal And Its Applications

EDWARD M. JAMES, chief chemist, The Sharples Specialty Co., presented a paper on June 12 at the joint meeting of the Process Industries Committee of the American Society of Mechanical Engineers and the American Institute of Chemical Engineers, in which he grouped the industrial problems which are solved by the continuous centrifugal into three classes:

1. Separation of solid from liquids, in which the principle of filtration cannot be used, or clarification.
2. Separation of solid from liquid, which depends upon the principle of filtration, or hydro extraction.
3. Resolution of more or less intimate mixtures of two immiscible liquids, or separation.

Problems falling under (1) are attacked by both low- and high-speed machines; under (2) by low-speed machines alone; and under (3) only by high-speed machines.

Mr. James described a number of the most interesting applications of the high-speed super-centrifuge, among them the removal of bacillus acidophilus from its broth culture (See *Chem. & Met.*, October, 1928, pp. 616-618). He then traced the development in this country of the low-speed, horizontal centrifugal, which when equipped with the fully automatic unloader becomes practically continuous. It is so used in the purification of wool-scouring liquors. The centrifugal process greatly simplifies the problem of stream pollution in view of the fact that only a small quantity of the liquor is wasted to the sewer each day; it greatly decreases the quantity of soap and soda ash required for scouring, since it takes advantage of the scouring properties of the naturally occurring potash salts; and in addition it produces a salable grease of a free fatty acid usually under 3 per cent. In certain cases even the dirt from the horizontal and the super-centrifuge is saved and sold as fertilizer.

Chemical Engineering Influences New England Industry

By GUSTAVUS J. ESSELEN and WALTER M. SCOTT
Boston, Mass.

A LARGE and well-known New England newspaper recently startled its readers with a front page headline reading: "New England Going Through Quiet Industrial Revolution." The purpose of the article which followed under this somewhat striking caption was to point out that in recent years this group of six states has been quietly achieving a healthy diversity of industrial activity rather than relying unduly on textiles and shoes, which had been the mainstay for many years. In other words, when the gradual working of economic forces decreed that New England was to share with other parts of the country the basic industries which she had developed, the migration which followed, far from weakening the economic structure of this section, actually strengthened it.

In order properly to appreciate the significance of manufacturing in the life of New England, it is of interest to sketch briefly its development from the days of the first colonists. The settlers here seem to have been manufacturers by nature, for manufacturing began as soon as the earliest settlements were well established. In fact, each new settlement constructed its grist mill almost as soon as its church or meeting house. Owing to the limitations of the wilderness, however, many ingenious schemes had to be worked out to make manufacturing even possible. This has continued through the years to such a degree that today the words "Yankee" and "ingenuity" are almost synonymous. At the present time, although the six New England states occupy only 2 per cent of the total area of this country, they contribute to the commerce of the nation over 10 per cent of the total value added by manufacture. In other words, this section adds to the wealth of the country five times the amount which would correspond to the proportion of territory which it occupies.

Inasmuch as New England was one of the first permanently settled portions of this country, it is only natural that it became the first permanent cradle of industry in America. For example, the first sawmill was built in Dorchester in 1628, and this, incidentally, was 35 years before such mills were introduced into England; the first leather was tanned at Salem in 1629 and within a short time the manufacture of shoes was established in Salem, Beverly, Marblehead, and Lynn, Mass.; the first fulling mill for wool was located at Rowley, Mass., in 1643; and the first iron works in America was established at Saugus in 1642. The cotton industry was inaugurated when the first cargo of cotton entered Salem harbor in 1638. The manufacture of salt by the evaporation of sea water according to a process patented by John Winthrop, Jr., in 1656, was also a flourishing industry in colonial days, as was also that of potash.

From the particular viewpoint of this paper it is of interest to note that many of these early industries involved chemical engineering, although obviously modern chemical engineering as we know it today was not dreamed of then. Nevertheless John Winthrop, Jr., son of the early colonial governor of Massachusetts, may properly be regarded as the first chemical engineer in this country, inasmuch as he was instrumental in initiating not only a new process for the recovery of salt from sea water but also was one of those responsible for the first iron works, as well as establishing plants for the manufacture of so-called black lead and of naval stores.

WHILE the raw materials of this region were adequate for the limited demands of the inhabitants of the early colonies, it was inevitable as the country grew, and large deposits of iron, coal, salt, and the numerous other essential mineral raw materials were discovered elsewhere, that New England should not permanently retain the chemical engineering industries which were founded here. In fact, for industry on the scale that we know it today, the mineral resources of New England are quite inadequate and contribute only about 1 per cent of the value of the total mineral production of the country. However, certain types of rock products are found in this section in profitable quantities. For instance, according to the census of 1925, New England produced, in terms of value, 50.7 per cent of the mica, 46.1 per cent of the feldspar, 44.9 per cent of the granite, 38.4 per cent of the marble, 36.3 per cent of the slate, 26.5 per cent of the talc, 20.7 of the trap rock, 12.7 per cent of the lime, and 10 per cent of the mineral water of the United States. More recent data indicate that the above ratios still hold.

When it comes to forest resources, on the other hand, New England is amply provided. Approximately two-thirds of the entire land surface is in forest or is potential forest land, and this forest area has been on the increase for some time. In fact, since the Civil War there has been a steady reversion of farm land to forests. The chief application of these forest resources is in the manufacture of wood pulp, of which New England manufactures more than one-half of that produced in the United States and consumes nearly as much. Maine

Presented originally at greater length on June 10, 1931, at the Swampscott meeting of the American Institute of Chemical Engineers under the title of "The Industrial Developments and Opportunities of New England."

leads all of the other states of the union in the amount of wood pulp produced, and New Hampshire occupies fifth place.

In addition to its forests, New England is fortunate in its water supplies. Within its comparatively small territory there are about a dozen major rivers and numerous smaller streams, in addition to a large number of natural lakes. In general, this water is not hard and requires comparatively little treatment to render it satisfactory for any type of industrial and domestic uses. During the year the annual precipitation in New England from rain and snow ranges from 35 to 46 in., and as a rule this precipitation is well distributed throughout the year. Another advantage of New England water is that even in summer it does not get unduly warm, making it useful the year round for moderate cooling, as, for example, in condensers. This, of course, is particularly true of the ground waters.

The fishing industry furnishes a striking recent example of how chemistry and chemical engineering are effecting marked improvements in industries to which at first sight they would seem to have little application. In recent years a new method of merchandising haddock sprang up, involving the separate packing of large slices of clear meat known as fillets. At first this was confined to a narrow market radius, because of the spoilage problem. Then, as a result of certain chemical studies, it was found that washing the fillets in a salt solution of a certain concentration exerted a sort of preservative action which kept them in perfect condition for ten days, enabling them to be shipped to Texas and even Pacific Coast markets. Most recent of all is the striking chemical engineering development of quick-freezing, which retains all the desirable flavor and structure of the fish yet permits storage without deterioration over long periods of time.

America's first chemical engineer was John Winthrop, Jr., son of the early colonial governor of Massachusetts, inasmuch as he was instrumental in initiating not only a new process for the recovery of salt from sea water but also was one of those responsible for the first iron works, as well as establishing plants for the manufacture of so-called black lead and of naval stores.

Aside from its forests, mineral deposits, and fisheries, New England has practically no raw materials, but its diversified industries provide a great consuming market for products from other parts of the country.

Economists agree that there are five fundamental factors involved in plant location and hence intimately connected with the industrial development of any section —namely, raw materials, labor, fuel (including coal, coke, oil, and gas), power (hydro-electric and steam-generated), and transportation facilities. While the importance of taxation and labor legislation as factors in plant location is fully recognized, they have not been included among the "fundamental" factors because they can be changed from time to time if they prove unwise. In fact this very thing has been taking place in New England during the last few years, particularly in connection with the taxation of manufacturing enterprises.

The raw materials situation in New England has already been considered. The labor situation here is satisfactory. In fact, New England is noted for the skilled character of its labor, which means a good deal for chemical engineering work. There also is an adequate supply of common labor.

While New England has large deposits of semi-graphitic coal, economic conditions are such that it is not feasible to work them at the present time. However, New England is within easy access to the anthracite fields of Pennsylvania on the one hand and the soft-coal deposits of West Virginia on the other hand. Cheap water transportation also brings a competitive fuel in the form of fuel oil brought by tankers from California, the Gulf Coast, and South America.

New England also is reasonably well situated with respect to power. Its own natural water-power resources have been more fully developed than those in other sections of the country, as indicated by the fact that while the estimated horsepower capacity of New England rivers and streams represents only about 3 per cent of the total for the whole United States, the developed capacity of this region in 1927 was 13.1 per cent of the total developed capacity of the nation. The most significant facts in the recent development of New England's power-using equipment are (1) the great increase in equipment operated by purchased electric current since 1914, (2) the relatively stable position of water-driven equipment since 1909, and (3) a substantial falling off in the fuel-burning equipment of private industrial plants since 1914.

The transportation facilities of New England are exceptionally good. There was early developed a network of intercommunicating rail lines, particularly throughout the more highly industrialized sections of the southern states of this group, and in recent years these have been to a considerable extent rebuilt. The relatively small distances in this area have been particularly favorable to the development of motor transportation for local hauls, and the three main rail systems give adequate connections to the South and West.

However, the real advantage which New England has in the transportation field, lies in its relatively long coast line. No other section of the country contains an equal number of bays and arms of the sea affording such safe and easy access to deep water. More than 70 per cent of the New England population live, and the major share of her industrial activity is carried on, within fifty miles of the seaboard. Thus this region possesses to an unusual degree the advantages of cheap water transportation for both export and import. An interesting example of the possibilities which this opens up is that of a New England ice-cream concern which has been making weekly shipments of ice cream by boat from Boston to Jacksonville, Fla., for the past three or four years and competing successfully in the Florida markets. Since the opening of the Panama Canal, Boston is nearer the Pacific Coast cities as measured by freight rates than is Detroit, Pittsburgh, Cleveland, or Chicago.

While so far we have been considering New England as a whole, it is of interest nevertheless to note that in reality only three states—Massachusetts, Rhode Island,

and Connecticut—are really industrial in character. Of course, there are notable exceptions to this generality, as, for example, what is probably the largest single chemical engineering development in New England has its headquarters in northern New Hampshire, and there are large textile mills in southern New Hampshire, as well as big pulp operations in Maine.

Table I—New England Industry, by States, All Manufactures, 1927
(All values in thousands of dollars)

State	Number of Establishments	Materials	Products	Value Added by Manufacture — Amount	Value Added by Manufacture — Per Cent of Total
Massachusetts	10,037	1,678,812	3,317,852	1,639,040	55.0
Connecticut	2,877	596,014	1,284,738	688,724	23.1
Rhode Island	1,497	313,107	592,233	279,126	9.4
Maine	1,426	208,866	372,094	163,228	5.5
New Hampshire	1,028	182,106	327,528	145,422	4.9
Vermont	880	69,957	134,030	64,073	2.1
Total	17,745	3,048,862	6,028,475	2,979,613	100.0

There seems to be a general impression that New England industry is largely limited to textiles and shoes, and it may therefore come as a bit of a surprise to learn that textiles comprise but slightly more than one-fourth of the total industrial activity of this region, and shoes only about 6 per cent. But the great keynote of the New England industrial situation today is the combination of great diversity of industry with a compact market of high purchasing power.

While it is true that the removal of large textile units from New England seemed at first to be a calamity, it has ultimately proved to be advantageous, in that a much more healthy diversification of industry has sprung up. In fact, in those centers which already have a sufficient number of textile or shoe-manufacturing plants, the local chamber of commerce or industrial bureau is pointing this fact out to prospective newcomers and suggesting that they locate elsewhere.

Furthermore, the New England Council is authority for the statement that "for every plant which New England has lost in the last four years, it has gained two new ones. For every worker who lost his job as the result of an industry's disappearance, one and one-half have been added to the new industrial payrolls of the region." These statements apply only to new industries and not to any gains or losses due to expansions or contractions of concerns already operating.

IN NEW ENGLAND, as elsewhere, there are some short-sighted manufacturers, like the whip manufacturer who refused to convert his factory to other purposes because he had decided to wait until the automobile fad had passed. Naturally, concerns like this do not last long, but in general New England industry has been keeping pace with the changing buying habits of the people. It is generally recognized that the era in which people spent most of their income for the primary needs of life has given way to a new era in which a much larger proportion of expenditures is for articles of convenience and luxury. As one example of how New England manufacturing has adjusted itself to the new trend there may be cited the fact that a large proportion of the radio tubes made in this country are manufactured here.

New England's chief industrial activity today is comprised in the group of metal-working industries, including the manufacture of machinery, particularly textile machinery and parts, cutlery and edge tools, plated ware, clocks and scientific recording instruments, typewriters, and hardware. It is because of the skilled labor to be found in New England that such industries thrive here. It is interesting in this connection to note that one of the nation's best known makers of carpenters' tools is concentrating all of its manufacturing in New England and in so doing has called upon chemical engineering to control atmospheric conditions in a unique factory which is to have no windows but in which electricity will maintain a uniform degree of illumination along with the constant conditions of temperature, humidity, and air circulation.

The manufacture of boots and shoes, both leather and rubber, is still an important New England industry, as is also that of leather tanning, Boston being the country's leading trading center for leather. In fact, the tanning of leather is increasing in New England more rapidly than in the rest of the country. The rubber industries of this country had their birth and early development in New England and this section still leads in rubber footwear and the so-called mechanical goods.

The making of wood pulp, paper, and paper products ranks sixth in importance as a source of revenue for New England and the plants of this region account for over 25 per cent of the total revenue for the United States. This is one of the few industries which obtains the major portion of its raw material from the native resources of New England, and with the extensive plans for reforestation which are now being carried out, there is little probability of a shortage in the supply of wood of known pulping qualities. In one or two instances, however, where a paper mill was situated near tidewater and its supply of wood has receded unduly, it has been found more economical to close down the pulp mill and use pulp made on the Pacific Coast. This trend will bear watching.

WITH all its diversified activity, New England is continuing its tradition as an industrial pioneer and a number of members of this institute have made outstanding contributions in this connection. Many of these developments are familiar to you, such as the production of building stone from a waste product in southern New England by Wilson and Edwards; and the perfection in northern New England of an unusually pure wood pulp with unique properties, by Richter and his associates.

Much of the early work on high-pressure steam installations was carried out in this vicinity and the mercury boiler in Hartford, Conn., has been operating for a number of years. Two leading firms which design and manufacture distillation and evaporation equipment have their headquarters here and J. V. N. Dorr, vice-president of the institute, maintains a semi-works experimental installation in Connecticut. Pioneer work in centrifugal casting of metals, has been carried out at the Watertown Arsenal and the local plant of the General Electric Co. One of the Boston sugar refineries is said to have been the first to change over from the old-type bag filters to modern filter presses. And so the list goes. These are but a few instances, cited at random, of the many examples of the appreciation on the part of New England industrialists of the value of chemical engineering as applied to their operations.

There are still, to be sure, many concerns that are trying to get along by using exactly the same methods as their grandfathers did, but obviously these are not the ones which are going forward. There is also much antiquated machinery, but this can be and is being replaced by those concerns which are successfully meeting competition.

Although much of New England industry does not fall within the strict classification of chemical engineering industries, nevertheless there are plenty of opportunities for the application of chemistry and chemical engineering to the profit of existing industries and the establishment of new ones. There is, for example, a new movement on foot in the carpet industry for sticking fibers to a chemical base rather than weaving them. In the textile industry proper, research has also been proceeding quietly and has shown some quite unexpected effects in the way of improved spinning and increased strength of yarns, by suitable chemical treatments of the fiber during the spinning operations. Paper specialties of various sorts have recently been developed in this region, at least two being deserving of special mention because of their close resemblance to certain grades of leather in toughness, porosity, and resistance to wear. And reference has already been made to a chemical engineering development which began in New England and bids fair to revolutionize many branches of the perishable food industry.

IN a general survey of the sort presented in this paper some discussion of future possibilities usually is expected. Often this is pure speculation, but in this case we are fortunate in having available the results of a three-year study just completed by the New England Telephone & Telegraph Co. This survey was unusually comprehensive and thorough and was carried out to guide the company in planning for future capital expenditures. Its conclusions therefore are worthy of more than passing consideration. After recognizing the general manufacturing character of New England's industries and the fact that this section offers a highly concentrated market for many of its own products as well as for those of other parts of the country, this report offers the following conclusions with regard to the development of New England over the next twenty years:

1. The population of New England will increase to approximately 10,000,000 people by 1950.

2. Manufacturing then as now will be the primary economic activity.

3. New England will have in 1950 approximately 400,000 more industrial jobs than today—an increase of practically one-third.

4. There will be to the advantage of New England, increases in water power resources to meet the wants of industry and the increased population.

5. The recreational industry will have achieved considerably more importance in 1950 and its growth will produce many beneficial results to New England.

6. The wealth and purchasing power will continue to grow and will be sufficient to support adequately a considerable volume of trading and service activities.

As other parts of the country continue their growth, it would be too much to expect that New England, which has played such a conspicuous part in both the political and economic development of this country, should continue indefinitely its position of leadership. However, with its diversified industries, its skilled labor, and its excellent transportation and banking facilities, there is every reason why it should continue to bear its proportionate part in the industrial development of the country and to reap its proportionate share of the rewards from the resulting prosperity.

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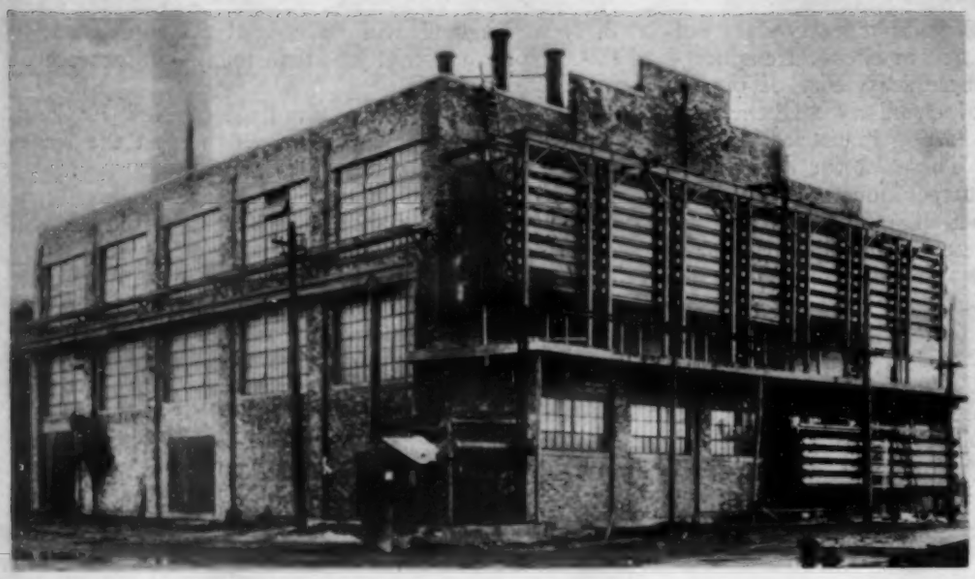
NOTE: The authors also acknowledge their indebtedness to Prof. H. C. Weber for helpful suggestions in connection with some of New England's special industries.

Where Chemical Engineering Helped Diversify New England Industry. Here, in the Plant of the Rumford Chemical Works, Ellery L. Wilson and Robert S. Edwards Developed a Synthetic Building Stone That Converted Gypsum Waste Into a Profitable Byproduct



Outside the New Merrimac Contact Sulphuric Acid Plant, Looking Toward the Trombone Coolers; Upper Banks Handle 98-Per Cent and Drying Acid, the Lower Bank 66-Deg. Acid

(All Illustrations Courtesy of Leonard Construction Co.)

Great Compactness Achieved in New Contact Acid Plant

By DANIEL S. DINSMOOR

Superintendent, Merrimac Chemical Co., Everett, Mass.

FOR MANY YEARS sulphuric acid has been a cornerstone of the chemical industry. Its annual tonnage is by far the largest of all the basic chemicals. Modern synthetic methods are competing for a portion of this tonnage, but as yet their inroads have not become serious. The wide range of industry served makes it probable that the importance of sulphuric acid will be maintained for many years to come. As a consequence, the trend of methods for its manufacture should be of interest to the entire chemical industry.

Up to about 1900 practically all sulphuric acid was produced by the chamber process. Laboratory investigators had pointed out and studied the effect of platinum catalysts on the rate of oxidation of sulphur dioxide. The successful commercial application of this work came about only after the discovery that the reason these catalysts soon became inefficient was the presence of impurities in the sulphur dioxide used. As arsenic was one of the chief offenders, its action was called "poisoning" of the catalyst. Careful purification of the sulphur dioxide eliminated this difficulty and made possible the growth of the contact method of manufacture.

This new method was responsible for the development of an entirely new technique. The only purification necessary for the chamber process had been the partial removal of the dust carried along from the various types of pyrites burner then in general use. Dust had, however, to be removed completely in the contact process; in addition the gas had to be scrubbed with acid to remove arsenic and to take out chlorine compounds which produced serious temporary poisoning.

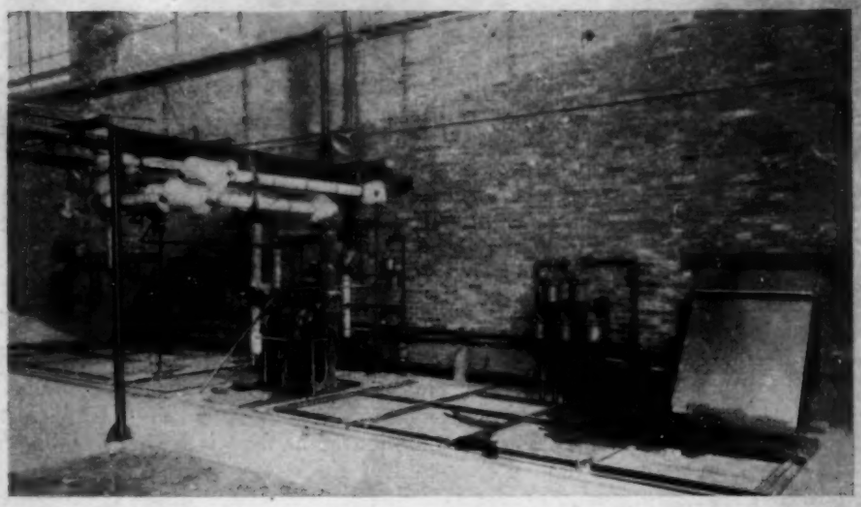
Presented on June 11, 1931, at the Swampscott meeting of the American Institute of Chemical Engineers, under the title of "A Modern Contact Sulphuric Acid Plant."

To carry out this purification it was necessary, of course, to cool the gas, and under these conditions the small percentage of sulphur trioxide formed in the burners appeared in the gas in the form of small particles of sulphuric-acid mist. This mist was very difficult to remove, although it was deposited freely in portions of the apparatus where it was least desired and was thereby responsible for severe corrosion. The mist also carried along some portion of the original arsenic content of the gas. Removal of this mist was accomplished by the use of large and expensive coke filters and more recently by Cottrell precipitators. Finally, it was necessary to dry the gas, as the moisture present from the scrubbing with weak acid was sufficient to cause corrosion in the conversion apparatus and also made absorption of the sulphur trioxide very unsatisfactory.

Purification therefore involved considerable expense. Moist sulphur dioxide is extremely corrosive, and practically all of the apparatus had to be constructed of lead. In addition to the capital investment and maintenance involved, the circulation of large volumes of acid for scrubbing and drying and the resistance of the purification system required considerable power consumption. Another difficulty was the disposal of the impure scrubbing acid, an ever increasing problem as the consumer continually demanded a product of higher quality. After the pure gas was ready for delivery to the catalytic mass, it was necessary to reheat it to the point where the catalyst became effective. Some plants used fuel for

this purpose, but well-designed units utilized the heat developed by the reaction, at least until the efficiency of the catalyst or the heat interchangers became impaired.

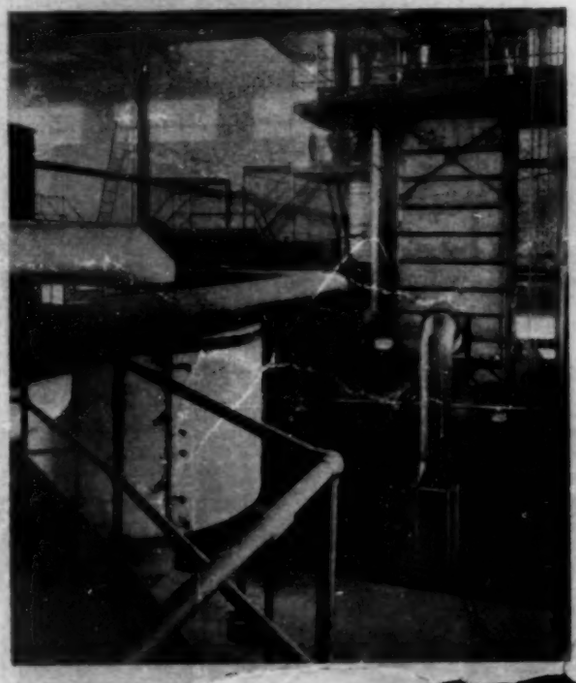
About 1926 the appearance on the scene of a satisfactory vanadium catalyst changed the picture considerably, as these catalysts were found to be immune to the usual poisons. This property eliminates the purification problem as far as the poisons are concerned and leaves the relatively simple proposition of supplying a reasonably dry and dust-free gas. There has been and still is disagreement as to the relative values of vanadium and platinum masses. The question of catalyst cost per ton of acid is complicated by such questions as the life of the mass, the recovery of platinum, fluctuations in the platinum market, and the increase of resistance in a unit due to physical changes in the mass over a period of years. Five years' experience with vanadium is not sufficient to give us all the facts necessary to answer these questions. This period, however, has been sufficient to convince many chemical engineers that vanadium will not only prove to be a cheaper catalyst but that, even if it were only on a par with platinum in this respect, its non-poisoning properties give it tremendous advantages.



Sulphur-Melting Pits, Showing Steam and Jacketed Sulphur Piping; Note Charging Chutes From Outside the Building; Variable Speed Pump Drive Appears at Left Center

The plant to be described is not offered as the ultimate in sulphuric-acid construction, either in principle or detail. It merely represents the attempt of chemical engineers of the Merrimac Chemical Co. to utilize to the best advantage the improvements made available by the properties of the new vanadium catalyst. To their experience in the acid field was added the advice of the engineers of the Monsanto Chemical Works, of which Merrimac is a subsidiary. The Monsanto engineers were not only experienced acid makers but also were thoroughly familiar with the vanadium catalyst, in the development of which they were the pioneers. The result of these efforts is a plant which has as yet only a short operating experience and for which no extravagant claims are made, but which undoubtedly will be of interest to the acid maker in particular, and to the industry in general.

Looking From the Sulphur Burner Platform Toward the Dry Tower (Right) With the Air Filter Below; No. 2 Converter Is at the Left; Note Dry Air Line to Sulphur Burner (Left Center) and Absorber (Center Rear)



As designed the plant consists of two units, each having a capacity of 50,000 lb. of sulphur per day. One unit has been completed and has been found fully capable of operating at high efficiency at this rate. Probably the most striking feature to the visitor is the small floor space required for a plant of this capacity. A previously built contact plant at this works consists of three units each having a daily capacity of 25,000 lb. of sulphur, two of them utilizing fine pyrites, while the third burns brimstone. The combined floor space of these older units, including burner building, purification apparatus, and conversion building, is about 40,000 sq.ft., a little over 1,000 sq.ft. per ton of sulphur per day. The floor space of the new building is about 5,600 sq.ft., or 112 sq.ft. per ton of sulphur per day. In spite of this drastic reduction in area, there is ample room and no crowding.

Sulphur is brought in by water to the Merrimac dock on the Mystic River, which is navigable up to this point for ships of 25 ft. draft. Cargoes of 4,000 tons can be discharged into storage without lighterage. From the storage pile sulphur is loaded into a hopper car of rather peculiar appearance. The hoppers are V-shaped, one side being perpendicular with discharge openings near the bottom of this side. The car, carrying a day's supply of sulphur, is placed alongside the building and the sulphur flows by gravity through a chute in the wall into the melting pit inside. When one hopper is empty, the car is moved along and the next hopper discharged.

Sulphur is melted by steam coils in two large brick-lined pits. Each pit has sufficient coil area to melt 100,000 lb. daily, the second pit being provided merely as a spare to insure continuous operation. In spite of the high purity of the sulphur now available, considerable foreign matter accumulates during shipment and storage, and this settles out in the bottom of the pit, thus re-

quiring periodic cleaning. The spare pit also provides for repair work on steam coils, which up to the present has not been necessary. The sulphur enters at one end of the pit and flows as it melts to the other end where the pumps for pumping the molten sulphur to the burner are located, thus giving all the opportunity possible for impurities to settle. At the pump end a baffle and screen prevent the solids from reaching the pumps. As the temperature of the molten sulphur is around 140 deg. C., any moisture present, of course, is evaporated before it can reach the pumps.

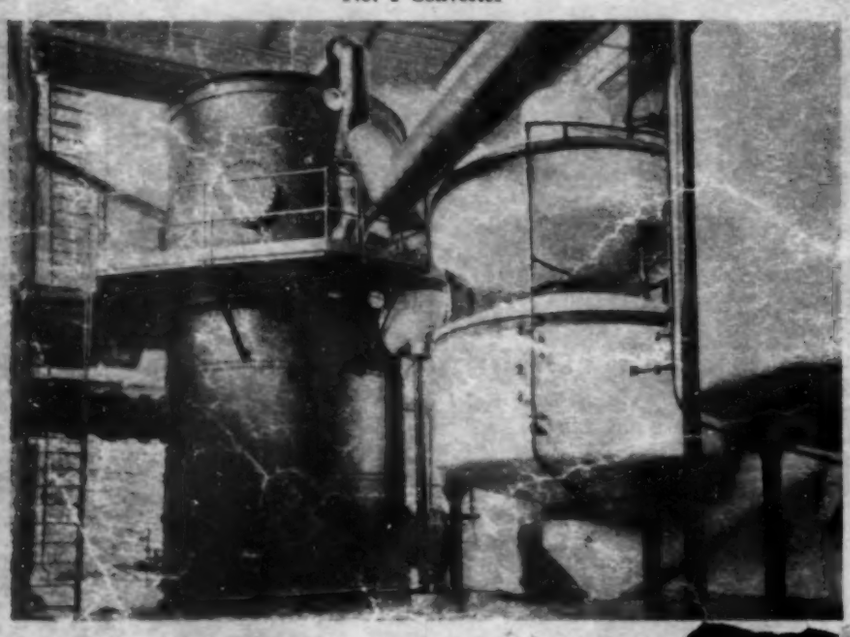
SIMPLE plunger pumps of the deep-well type are used, and to keep the pumps hot, the barrels are immersed in the liquid, extending nearly to the bottom of the pit. Some trouble has been experienced as a result of piston rings sticking, but renewal of rings is not difficult and a spare pump always is kept hot in the pit, ready to start at a moment's notice. The pumps are driven through a variable-speed reducer, which makes it possible to vary the feed over a wide range. Steam is maintained at 60 lb. pressure, insuring a temperature well above the melting point, while avoiding any possibility of the sulphur becoming viscous. Pipe lines and control cocks from the melter to the burner are all steam-jacketed and, of course, lagged.

Air supply is taken from within the building, the large volume of fresh air which is drawn in daily assuring adequate ventilation. Dust is removed by a standard dry-air type unit, consisting of baffle sections, the surfaces of which are coated with special oil. This unit occupies a floor space about 30 in. square, and the resistance at full capacity is only ½ in. of water. The drying tower follows the trend of recent experiment and experience in this company's older plant, and consists of lead walls supported on a steel frame and lined with acid-proof brick. The packing is made up of glass plates set on edge and supported on courses of brick set into the tower lining. This type of tower is very compact, the space required being only about 8½ ft. square. The over-all height of about 35 ft. is not excessive when it is considered that the tower bottom is itself 13 ft. above the floor, in order that the acid may flow by gravity back to storage. Acid circulation is about 75 gal. per min. of 66 deg. Bé. acid. Drying is very good, moisture tests showing on the average about 1½ mg. of water per cubic foot of air.

One difficulty with this type of tower is the large quantity of acid carried along mechanically in the air. In spite of great care in the design of the distributor to avoid splash, the acid passing the exit of the tower amounts to as much as 60 grams per hour. Fortunately, most of this separates in the large steel pipe lines leading to the blower and is drained through a lute at a low point in the line. Tests beyond this point indicate about 0.3 gram per hour entering the blower. Insertion of a simple baffle section probably will decrease this quantity without adding much resistance. The clean dry air is pumped through the rest of the unit by a blower of the usual high-pressure type, with a capacity of about 5,000 cu.ft. per min. Regulation of the volume is accomplished by means of a bypass valve. The drying tower is the only portion of the apparatus which is operated under suction.

The sulphur burner consists of a vertical steel cylinder lined with firebrick. Being 13 ft. in diameter and 25 ft. high, it seems large to one familiar with the ordinary rotary type, but complete combustion is very important. It is divided into two sections by a firebrick arch, the upper section comprising about one-third of the height. The molten sulphur enters through a pipe at the center of the top and falls on a tile plate at the apex of a checker-work pyramid supported on the arch. The air enters through two flues, one very close to the sulphur inlet and the other at the height of the arch. Baffles are provided to distribute the air uniformly around the circumference, and dampers permit the volume entering at each point to be controlled so as to prevent overheating of the top of the burner. The air and burning sulphur pass through a large opening in the arch into the lower section, where the sulphur drops onto another checker-work pyramid in order to have adequate combustion surface. A clean-out door at the bottom permits removal of dirt which may accumulate.

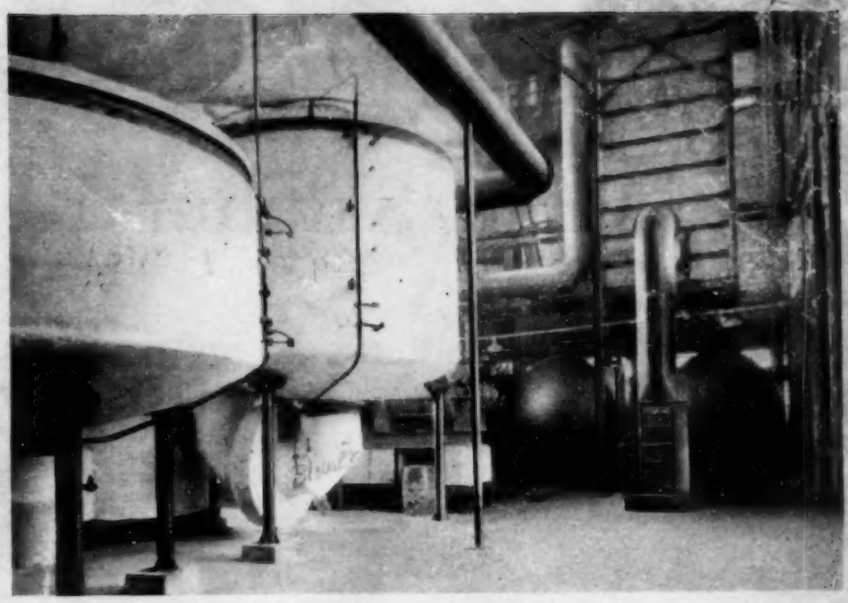
Molten Sulphur Burner (Left), No. 1 Converter and Filter (Center) and No. 2 Converter (Right); the Cast Iron SO_2 Line to the Coolers Appears Behind No. 1 Converter



This burner has proved very satisfactory, the completeness of combustion being indicated by the fact that the blower can be stopped within a minute after the sulphur pump is shut down and no sulphur detected in the burner. The steel shell was built for 5 lb. pressure and no gas leakage has developed. Gas strength is easily controlled and remains very constant as long as conditions are left unchanged. To start the plant it is necessary to preheat the burner, and for this purpose nozzles are inserted in the shell through which oil burners can be introduced. These nozzles are closed by tight caps when the burner is operating and a quartz sight glass set in one of the caps permits interesting observation of the sulphur burning with a pale blue flame.

Combustion of 50,000 lb. of sulphur per day evolves somewhat more than 8,000,000 B.t.u. per hour, while the conversion of sulphur dioxide to sulphur trioxide produces

over 2,000,000 B.t.u. per hour additional. The gas temperatures must be carefully controlled in the converters and finally brought to a reasonable temperature for absorption. Radiation from the burner amounts to about 2,000,000 B.t.u. per hour, the balance of the heat being removed by an air cooling system. The hot gas from the burner enters a cast-iron shell, passes up over a brick baffle wall, then down and out of the bottom on the other side. The whole cast-iron shell is inclosed in a steel shell through which cooling air is passed. This type of construction is not necessary beyond this point and the remaining coolers for control of temperature at the converters and absorber are of tubular type, constructed wholly of steel. Cooling air is supplied by a single fan of 15,000 cu.ft. per min. capacity to a steel duct common to all the coolers. Dampers control the volume through each cooler, and the hot air leaving the coolers is again collected in a common duct, from which it passes to a water heater. This system removes approximately 5,500,000 B.t.u. per hour, which is recovered for use in other processes.



Converters, Blower No. 1, Air Filter, and Dry Tower With Absorber and Acid Tanks in the Background

Conversion is carried out in two stages, the gas being cooled between the two in order that it may leave the second converter at the optimum temperature. These converters are cast-iron shells 11 ft. in diameter and are believed to be the largest conversion units as yet attempted in the industry. The catalyst is Monsanto vanadium mass, which rather resembles split dried peas in appearance, though the individual pieces are actually half cylinders. The mass is loosely packed on iron screen shelves suitably supported, and internal baffles are inserted between the shelves to prevent channeling. The first converter contains two shelves, each carrying 7½ in. of mass, while the second consists of three shelves 12½ in. deep. About 80 per cent of the work is done in the first converter, the final conversion efficiency being 96.5 per cent to 97.0 per cent.

As a protection against any dust present in the gas, a filter section is installed ahead of the first converter. This section is of the same diameter as the converters, and the packing consists of 14 in. of material exactly like the catalyst except that it contains no vanadium. Absorption takes place in a steel tower lined with acidproof brick, which is packed with ceramic rings and French pebbles, and has the usual plate type of distributor.

Storage tanks are provided for drying acid, 98-per cent absorbing acid, and product. The circulation system consists of a small brick-lined tank, duplicate self-priming pumps, and a cast-iron trombone cooler through which the acid is pumped under pressure to the top of the absorbing tower. The drying-acid system is similar except that the small reservoir tank is omitted, the main storage tank serving this purpose. The pumps are located on what might be called the second floor level and are directly in front of the door of the control room. The latter is strategically placed so that practically all parts of the plant can be seen through its windows. All control instruments, so far as possible, are located on the wall of this room. Important temperatures are shown on a recording instrument and additional readings are available by the use of an indicator and switches. Gages show the pressure at all points. Gas strength is recorded on an automatic instrument and checked on the familiar Orsat apparatus. Exit gases also are piped to this point for determination of conversion efficiency. The strength of the absorbing acid is measured on a "titrimeter," a simple device depending on the variation in conductivity, and is frequently checked by the heat-rise method. An acid-testing bench and tool lockers complete the equipment. To guard against escape of sulphur trioxide from the absorbing tower, an automatic shut-off is installed, which stops the sulphur pump and blower in case the flow of absorbing acid on the tower ceases for any reason.

Operating experience to date has been discussed in connection with the description of each section of the apparatus. One very important feature of a contact plant is the power consumption. This unit was designed particularly for low resistance and the total blower pressure at full capacity is only 3 in. of mercury. Previous plants of half the capacity have had a total resistance of as much as 7 in. of mercury. The saving in power is obvious. One operator can easily handle the plant under normal conditions, although a mechanic is added to the day shift for oiling, packing pumps, and in general to keep the equipment in first-class mechanical condition. Acid produced is of excellent quality. The entire production is turned out as 66-deg. acid, as existing plants already furnish sufficient fuming acid.

CONSTRUCTION of a second similar unit will involve minor changes, but it appears at present that there will be no radical departure from this design. It must be kept in mind that time will be required to tell definitely wherein its strength and weakness lie, and that the catalyst and novel features of the process and equipment are the subject of patent applications. The engineers responsible for this unit cannot but be pleased with its performance. It is their hope that the description of this particular attempt to produce a better sulphuric-acid plant will be of interest to the profession.

Flash Combustion Roasting of Pyrite for High Sulphur Recovery

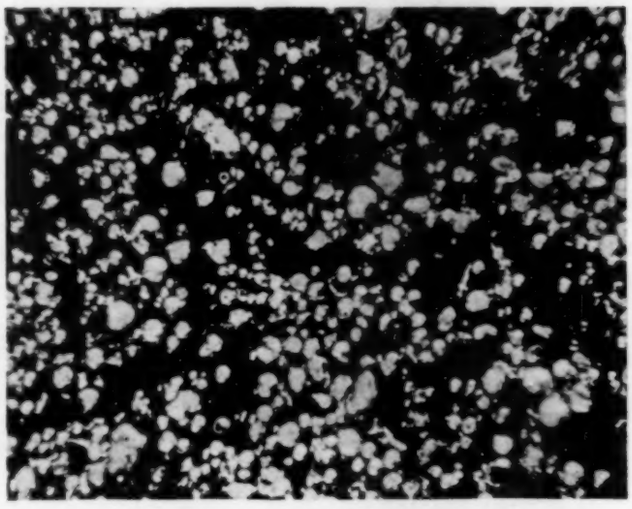
By HORACE FREEMAN

President, The Sulphide Research Corp., Ltd.
Montreal, Canada

CONCENTRATION of base-metal sulphide ores by the flotation process has, during the past 20 years, received a very extensive development. The finely divided concentrates produced by the process have involved numerous changes in the metallurgical methods required for the subsequent handling, roasting, reduction, and other operations. From many mixed sulphide ores the flotation process has made available a concentrated byproduct of iron pyrites ground to 200 mesh and even finer, containing 50 per cent of sulphur and a minimum quantity of gangue material. When this high-grade product is roasted in the mechanical types of roasters at present in use—for example, the Nichols Herreshoff—it is found that, on account of the rapid roasting of the fine material and the greater amount of heat generated, the capacity of the roaster is considerably decreased and the wear and tear on brick work and rabbles, and the cost of roasting, are correspondingly increased.

Problems Involved—The development to be described here arose out of a detailed consideration of the chemical-engineering problems involved in introducing pyrite, and particularly the concentrated product, which is becoming available in Canada in considerable quantity, into the Canadian paper industry. It was felt that the investment in the Herreshoff roaster would be too large for the comparatively small requirements of the average paper mill, the operating costs would be excessive, the type of gas produced would not be suitable in the equipment used for the manufacture of sulphite acid, the yield of sulphur dioxide would be low, the fine red oxide produced would make an undesirable nuisance in a paper mill, and impurities in the pyrite, such as selenium, would cause trouble in the sulphite digesters. It was also felt that the existing methods of using sulphur in the paper mill would bear chemical-engineering examination and that any process using pyrite successfully should also overcome the objections involved in making sulphite acid from brimstone.

Experiments were initiated at Shawinigan Falls, involving the combustion of suspended particles in streams of air projected in various ways into combustion chambers. It was early found that preheating of the air was not necessary, except for the purpose of drying the pyrite. The best method of combustion of pyrite was found to be by injection with air downwardly into a vertical combustion chamber, in such a manner that only a part of the air needed for complete combustion was used to convey the pyrite, the remainder being caused to flow upwardly from the bottom of the chamber, countercurrent to the falling pyrite. In this manner the air entering from the bottom was preheated by the heated particles falling through it and the particles having the lowest sulphur content were meeting air with the highest oxygen content. Fresh particles of pyrite entering at the top were rapidly heated, distilling off an atom of sulphur which mixed and combined with any oxygen remaining in the gases passing out of the top of the combustion chamber, so tending to give the highest possible percentage of sulphur dioxide in the products of combustion.



Photomicrograph of Calcine, Magnification 26 Diameters

One of the problems involved in the use of pyrite for sulphite acid preparation lay in sulphur trioxide formation which often, due to the presence of finely divided iron-oxide catalyst, might run considerably above the economic limits allowable. Investigation of the amount of heat generated in the early furnaces showed that higher temperatures could be developed than when burning the equivalent brimstone, and that these high temperatures could be utilized to minimize trioxide formation, since SO_3 is practically completely dissociated at 1,000 deg. C. The necessity then arose to cool the

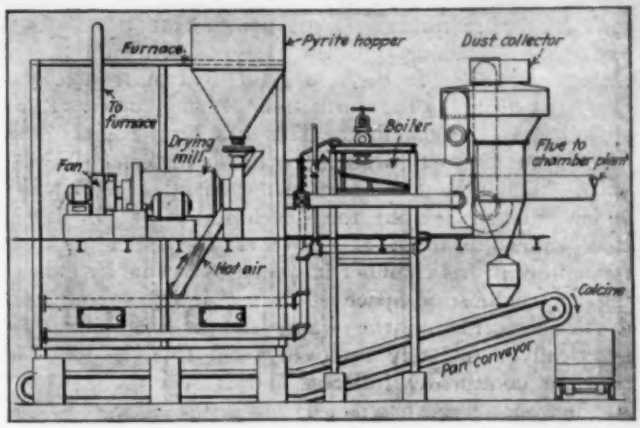
Presented on June 11, 1931, at the Swampscott meeting of the American Institute of Chemical Engineers, under the title of: "Flash Combustion Roasting of Iron Pyrites."

Guarantees

gas rapidly down through the temperature range favorable to trioxide formation while the gases contained suspended iron oxide. Twice the amount of heat is developed, compared with burning the equivalent brimstone, and therefore it was felt that a steam boiler would serve as an efficient cooler and that the steam recovered would largely pay the operating expenses. The problem of further cooling the gases after passage through a steam boiler also was tied up with the necessity of washing the gas free from dust particles and other impurities, so that it would be suitable for the manufacture of sulphite pulp. Among the impurities objected to by the sulphite manufacturers is selenium, which is said to act as a catalyst in the sulphite digesters, forming sulphuric acid.

In the practice of burning sulphur in paper mills it is rare to find any consistent attempt to maintain high temperatures in the combustion chamber, nor is any attempt made to cool the gas as rapidly as the velocity of the oxidation reaction ($2SO_2 + O_2 = 2SO_3$) requires. Gas usually is led through lengthy cast-iron ducts at a temperature favorable to sulphur trioxide formation before entering the externally cooled lead coolers. There is no attempt made to wash the gas free from the trioxide which forms, but a certain quantity of condensed sulphuric acid is run off from the bottom of the lead coolers. The remainder passes on into the limestone absorbers, there to form calcium sulphate crusts.

In the writer's experience in Canadian paper mills, the efficiency of conversion of brimstone to available sulphur dioxide varies from 80 per cent to 95 per cent, according to the equipment and method of operating the burners. The sulphur consumed per ton of pulp may vary over wide limits (from 200 lb. to 350 lb. per ton of pulp), due to the gas losses mentioned above, as well as other losses. If we refer strictly to conversion of

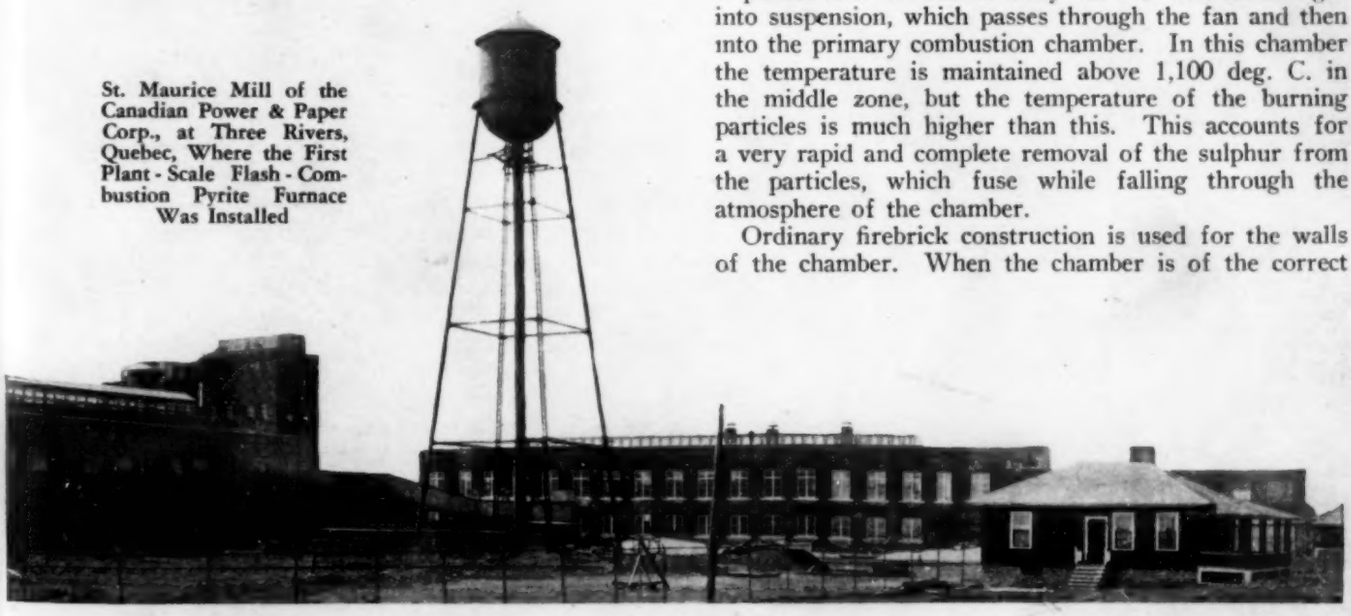


Layout of Flash-Combustion Roaster as Designed for a Chamber Sulphuric Acid Plant

sulphur to sulphur dioxide, it is rare that we find a small paper mill installation consuming, say, 10 tons of sulphur per day which attains the efficiency of sulphuric-acid plants using larger quantities and reaching sometimes 96 per cent efficiency. This problem, therefore, was particularly considered in connection with small pyrite installations. Electrical methods of cleaning the gases were costly for small installations, and since any trioxide and selenium in the gases could be removed by washing, for final cooling after the boiler direct scrubbing was adopted, particularly as the set-up would be cheaper than the usual lead cooler.

Flash Roasting—The pyrite preferred for the process is flotation pyrite dried down to about 2 per cent or 3 per cent moisture content and containing 50 per cent or so of sulphur on the dry basis. It has been determined, however, that the ordinary large-lump pyrite, containing 45 per cent sulphur, can be quite successfully used. The material is fed from the storage hopper into a ball mill, which serves as a dryer, as a grinder, and to bring the sulphide into suspension in the air. In the case of lump pyrite, the full charge of balls is used in the mill, but in the case of flotation material a very light charge of balls is used, since it is necessary only to break up any agglomeration. As was previously stated, warm air is passed into the mill to carry out the material brought into suspension, which passes through the fan and then into the primary combustion chamber. In this chamber the temperature is maintained above 1,100 deg. C. in the middle zone, but the temperature of the burning particles is much higher than this. This accounts for a very rapid and complete removal of the sulphur from the particles, which fuse while falling through the atmosphere of the chamber.

Ordinary firebrick construction is used for the walls of the chamber. When the chamber is of the correct



St. Maurice Mill of the Canadian Power & Paper Corp., at Three Rivers, Quebec, Where the First Plant-Scale Flash-Combustion Pyrite Furnace Was Installed

dimensions, no fluxing of the material on the walls is experienced, although, in our early experiments and in the experiments of others, a great deal of trouble was encountered from the formation of slag, or scarf, on all sides of the chamber. This has been found to be due to the attempt to burn too much material per unit of time and unit of volume in the chamber, a difficulty which greatly delayed the development of powdered-coal combustion methods. In other words, slag or crust formation in this chamber has been overcome by enlarging the combustion space. A crust of only about ½-in. thickness forms on the walls, and as the sulphur is practically completely removed from this, it does not slag but continually falls off and is renewed.

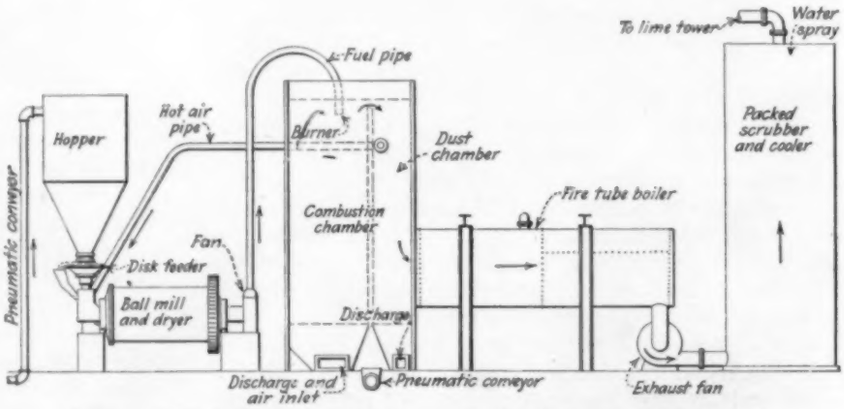
The gases pass downward into a second combustion chamber and their temperature, at the entrance to the boiler tubes, is in excess of 1,000 deg. C. The velocity through the boiler tubes is so high that the tubes are self-scouring and the rate of cooling is very rapid. The rapid cooling of the gases from above 1,000 deg. C. to below 400 deg. C. accounts for the almost total freedom of the gases from sulphur trioxide, even though there is a considerable quantity of free oxygen and gas-floated catalytic oxide present. The gases leave the boiler at about 200 deg. C. and contain 0.1 per cent sulphur trioxide. At this temperature and concentration there is no condensation on the boiler surfaces.

Still at this temperature the gases enter the final cooling and washing tower, which is packed with acid-proof spiral tile filler, over which is sprayed just the amount of water necessary to cool the gases to within 10 deg. of the water temperature. This water, in its passage down the tower, washes out the dust and dissolves traces of sulphur trioxide as well as other impurities. In doing so it becomes heated, so that when it discharges at the bottom of the tower its temperature is from 70 to 80 deg. C. The dimensions of the washing tower and the quantity of water used in it are, of course, proportional to the volume of gases to be handled and their entering temperature. These have been closely defined and reduced to commercial practice.

It will be seen that the boiler and the washing tower together comprise the cooling system and are the equivalent of the lead-pipe externally cooled systems which are at present used on brimstone installations. It has been found that this cooling system is cheaper to install and to operate, and that there is a difference of at least 3 to 5 per cent in the efficiency of sulphur conversion to sulphur dioxide by such rapid cooling. Here it may again be remarked that the temperatures developed by pyrite are considerably higher than those developed in the present practice of handling sulphur, and this is a factor in preventing the initial formation of trioxide.

As will be seen from the operating report reproduced here, about 0.5 per cent of the total sulphur used is lost as trioxide, and about 0.5 per cent as dioxide in the scrubber water. The remaining sulphur lost is in the calcine, and this loss has been reduced to 0.2 per cent of the weight of the calcine, making a total sulphur loss of 1.38 per cent.

Steam yield from the boiler exceeds 1 lb. of steam per pound of pyrite consumed, which pays the cost of operation of the burner. The oxide produced is in the form of fused particles or hollow shells of magnetite, containing about 65 per cent of iron. It contains the gangue material ordinarily produced in flotation concentrate, of course, but it is being found that most of this can be eliminated by magnetic separation, and that the sulphur content, as consistently produced, is below 0.2 per cent. This material is especially interesting as a high-grade iron ore, free from phosphorus and low in sulphur. It may be sintered or briquetted. It is even more interesting as a raw material for sponge-iron production, to be directly smelted in electric furnaces without the usual cooling of the iron powder and magnetic separation between the reducing kiln and the electric furnace.



Layout of Flash-Combustion Roaster as Designed for Producing Sulphite Acid in a Paper Mill

Operating Report on Flash Combustion of Pyrite

Sulphur in pyrite, per cent	50.
Pyrite burnt, pounds per minute	20.83
Equivalent sulphur burnt, pounds per minute	10.415
Cooling water used in scrubber, pounds per minute	40.0
SO_3 in cooling water, per cent	0.3472
SO_3 in cooling water, pounds per minute	0.1388
SO_3 in cooling water, per cent	0.2976
SO_3 in cooling water, pounds per minute	0.1190
Sulphur in cinder, per cent	0.203

Sulphur Losses

Loss in cooling water as SO_2, pounds per minute	0.0493
Loss in cooling water as SO_2, per cent of total entering	0.4733
Loss in cooling water as SO_3, pounds per minute	0.0545
Loss in cooling water as SO_3, per cent of total entering	0.5232
Loss in cinder, per cent of total entering	0.2806
Total sulphur loss (in cinder and in water), per cent	1.3846
Recovery of available sulphur	98.6154
Steam production, equivalent evaporation from and at 212 deg. F., pounds per hour	1,328

▼ ▼

Manometer for Higher Pressures

DESCRIPTION of an interesting type of differential mercury manometer for the measurement of relatively high pressures appears in the June number of the *Bureau of Standards Journal of Research*. This device was developed for the accurate measurement of pressures to 15 atm. (about 220 lb. per square inch). Instead of a single column or U-tube, the manometer consists of five separate U-tubes connected in series. The lower half of each tube is filled with mercury and the upper half with water. When pressure is applied at one end of the series the sum of the differences in mercury height in the two legs of each tube can be taken as a measure of the pressure, accurate to one part in 10,000. Such a device is far more compact than a single tube for this service would be.

Combustion of Pyrite in a Herreshoff Furnace

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CONDITIONS imposed in burning iron pyrites for the manufacture of contact sulphuric acid are more exacting than those encountered in the roasting of sulphur-bearing ores in the metallurgical industries. The gas concentration must be between 8 and 12 per cent sulphur dioxide; sulphur recovery should exceed 95 per cent; the operating and fixed charges on the equipment must be met entirely by the burner gas produced; and the equipment must be able to operate continuously without shutdown. It is essential that a burner gas of uniform analysis, containing always in excess of 8 per cent sulphur dioxide, be produced continuously. Furthermore, at times there will be a demand for gas of higher concentration to operate the converters at maximum capacity. As raw material cost is a large item in sulphuric-acid manufacture, high sulphur recovery from the cinder is important. The cinder, under present conditions not only of no value, but requiring dumping expense, cannot share the cost of burning, as would be the case in metallurgical operations.

A contact plant represents an investment many times the cost of the burner and is dependent economically as well as technically on continuous operation. Interruptions in the delivery of gas to the plant are felt directly in cost of production, both on account of higher operating and fixed charges and on account of lower efficiency. There is also the added possibility of introducing an item for fuel to maintain correct converter temperatures.

Combustion of pyrite, an exothermic reaction producing about 2,400 B.t.u. per pound, is theoretically sufficient to raise the reaction products to about 800 deg. C., if the sulphur dioxide concentration of the gas is 8 per cent. To carry this reaction to commercial completion it is necessary that a temperature of over 600 deg. C. be maintained for sufficient time to allow oxygen to diffuse into the ore and remove the sulphur content. Below 600 deg. C., oxidation to sulphate occurs, with a resulting sulphur loss in the cinder. At temperatures somewhat above 800 deg. C., slagging of the pyrite is rapid and corrosion of metals in contact with it becomes serious.

It is evident, from the relatively small amount of heat available and the narrow limits of high temperature between which the reaction proceeds smoothly, that the construction of any successful equipment for burning pyrite must be based on sound chemical engineering.

A recent development in the combustion of pyrite for producing sulphuric acid is the use of a Herreshoff furnace capable of handling over 30 tons of pyrite fines per day. In this furnace, ore is rabbled from top to bottom over 12 horizontal shelves, air for combustion is admitted through ports at the bottom, and burner gas containing between 8 and 12 per cent sulphur dioxide is withdrawn from the top. The rabbles are driven by a vertical central shaft revolving once or twice per minute. Cooling of the metal shaft and rabbles is accomplished by air which circulates up through the shaft, into the rabble arms, and out through a vent in the top.

Agitation during oxidation of the ore and cooling of the rabbles have proved difficult problems. The temperatures to which these metal parts are subjected offer difficult corrosion problems which directly affect the dependability of the burner. Water-cooling might be expected to reduce corrosion difficulties considerably, but the cooler metal surfaces extract too much heat and cause sulphating. Therefore, air-cooling has been resorted to in order not to remove too much heat in the cooling medium, but the rabbles must operate with the metal at a high temperature. Another drawback to air-cooling is the ever present leakage of air into the combustion space. This amounts roughly to 10 per cent of the air requirements under good operation and hampers control of combustion.

The classical explanation of the mechanism of iron pyrites combustion assumes "flashing" of half of the sulphur as soon as the ore is heated, leaving a residue of iron sulphide. The sulphur evolved burns rapidly with oxygen from the air. This is followed by a slower combustion of the residual sulphide sulphur. Decomposition of pyrite into iron sulphide and sulphur occurs slowly in vacuo at about 600 deg. C. In an atmosphere of nitrogen at 850 deg. C., decomposition is complete in one hour (M. G. Marchal, *Bull. Soc. Chim.*, Vol. 35, p. 43). If this reaction is allowed to proceed uncontrolled, localized high temperatures result on the upper shelves, with insufficient heat on the lower ones to complete oxidation of the residual iron sulphide. This leads to frequent shutdowns to replace burnt-out rabbles and low yield, due to high sulphur loss in the cinder.

A series of tests (unpublished theses of the M.I.T. School of Chemical Engineering Practice: Jamison, Miller, and Welcyng, 1928; Bose and Koo, 1929) has been conducted to follow the progress of the combustion reactions through a 30-ton air-cooled Herreshoff furnace burning pyrite fines. Samples of the ore were removed from each shelf at the point where it feeds onto the shelf. Temperatures indicated by thermocouples installed in wells above the bed were recorded during the run. Uniform operating conditions, as indicated by rate of feed, temperatures, and exit gas analysis, were maintained for a reasonable length of time previous to removing samples. These were analyzed for iron, total sulphur and, on two runs, sulphur present as sulphide. The original ore was analyzed also for moisture and for free sulphur. The tabulation shows a summary of operating conditions during the tests. In Run No. 1 the furnace was operat-

Presented on June 11, 1931, at the Swampscott meeting of the American Institute of Chemical Engineers; very slightly condensed.

Summary of Tests on Herreshoff Furnace Burning Pyrites Fines, With and Without Radiation Coolers

		Per Cent			Per Cent — Runs Nos.
Pyrites Analysis:	Total sulphur	46.0	Gas Composition:		Run No. 1 / 2 and 3
	Free sulphur	0.25		SO_2	11.7 / 8.7
	Sulphur as sulphate	0.76		O_2	6.9 / 8.0
	Iron	42.7		N_2	81.4 / 83.3
	Moisture	2.0—6.0		Dust[1]	400–500 mg. per cu.ft.

	Without Radiation Coolers	With Radiation Coolers							
	Run No. 1	Run No. 2				Run No. 3			
Location of Sample	Lb. S. per 100 Lb. Fe.	Lb. S. per 100 Lb. Fe. Total	Sulphide	Sulphate	Temp. Deg. C.	Lb. S. per 100 Lb. Fe. Total	Sulphide	Sulphate	Temp. Deg. C.
Burner gas	....	....	....	....	662	....	....	....	750
Feed, shelf No. 1	113	108	None	1.91	...	107	None	1.66	...
Entering shelf No. 2	117	97.4	None	0.68	535	89	None	0.78	568
Entering shelf No. 3	70	81.9	0.22	0.46	734	75.4	1.10	0.66	739
Entering shelf No. 4	43.5	58.5	0.99	0.70	717	57.4	1.08	0.78	724
Entering shelf No. 5	48.6	43.1	1.01	0.69	844	35.4	0.18	0.91	834
Entering shelf No. 6	24.4	35.3	0.64	0.69	732	32.2	None	0.60	729
Entering shelf No. 7	26.6	33.2	Small	0.74	715	28.4	Small	0.62	717
Entering shelf No. 8	10.4	25.4	None	0.66	580	23.2	Small	1.09	622
Entering shelf No. 9	12.5	24.6	None	1.17	577	19.4	None	1.47	612
Entering shelf No. 10	12.0	11.4	None	1.23	344	11.5	None	2.12	418
Entering shelf No. 11	4.9	....	....	....	263	....	....	....	354
Entering shelf No. 12	2.8	....	....	....	82	....	....	....	133
Cinder[2]	3.8	11.1	None	3.44	...	5.9	None	3.11	...

[1] Dust analysis based on data presented by J. J. Healy, Jr., (*Trans. Amer. Inst. Chem. Eng.*, Vol. 24, p. 37) on a similar furnace.

[2] It should be noted that plant records taken over a year's period for this type of furnace handling 27 tons of iron pyrites per day show elimination of sulphur to below 1 per cent. This is equivalent to about 1.7 lb. of sulphur per 100 lb. of iron in the cinder.

ing as installed, producing a high concentration gas. Runs No. 2 and No. 3 were made after radiation coolers had been installed on the upper six shelves, at a time when a lower gas concentration was desired.

The same tabulation presents the results of these tests. The analyses are all expressed on a uniform basis of iron content. The variation from a smooth curve of the values reported for pounds of sulphur per 100 lb. of iron for Run No. 1 is due to a lack of precision in sampling rather than to burner operation. It will be noticed that in Run No. 1 about 80 per cent of the sulphur is burned out in the first five shelves. The temperature rises rapidly to well over 800 deg. C. at the fifth shelf and then falls off. This difficulty has been largely overcome by inserting radiation coolers in the top six shelves, where flashing occurs, and speeding up the travel of ore over these shelves by adjustment of the angle of the rabbles. The effect of this change on temperature is very noticeable in Runs No. 2 and No. 3. On only one shelf does it exceed 800 deg. C., whereas the temperatures at the bottom of the furnace are much higher than in the first run. The distribution of sulphur removal is much more uniform, requiring eight or nine shelves to remove 80 per cent of the sulphur, but cinder losses are higher.

Typical temperature and sulphur-removal curves for Run No. 3 are shown in the chart where shelf numbers are plotted against sulphur present as a percentage of the initial sulphur content, and against temperatures on the various shelves. Combustion proceeds at a substantially constant rate on the first five shelves, reaching a maximum temperature on the fifth shelf. Temperature decreases gradually below this shelf and the rate of combustion becomes less.

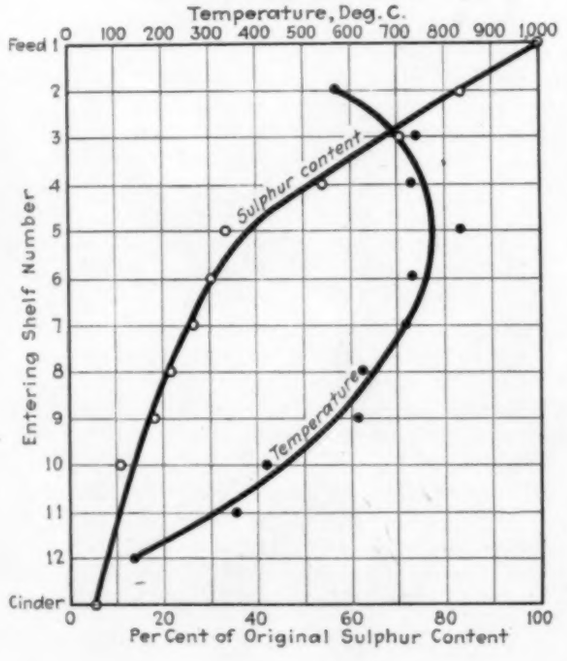
One drawback in the use of radiation coolers is that the amount of heat abstracted seriously affects burner operation when the moisture content of the feed runs high. A small amount of heat escapes from the furnace into the feeding pan on top of the furnace, evaporating 1 or 2 per cent of moisture and preheating the ore to about 80 deg. C. The heat available for drying is insufficient to prevent balling of wet ore. The balls sinter and pass through the furnace without appreciable reduction in sulphur content.

The sulphide analyses throw considerable light on the mechanism of the reaction. The rate of flashing is slightly greater than the rate of combustion of iron sulphide, but at no time is more than 3 per cent of the total sulphur present as sulphide. Maximum sulphide occurs before maximum temperature is reached. The change in the amount of sulphide present is small when compared to the relatively large decrease in total sulphur content on the same shelves. All of the sulphide is removed before the ore drops below 600 deg. C. Although flashing apparently does occur to a limited extent, the rate of this reaction is small at the temperature involved.

The sulphate analyses show that at temperatures above 600 deg. C. very little of the sulphur is held in this form, but at lower temperatures sulphate formation takes place. This is in acocrd with data on the vapor pressure of sulphur trioxide above ferric sulphate.

Summary—The combustion of iron pyrites for the manufacture of sulphuric acid requires a high sulphur-dioxide-content gas, high sulphur recovery, low operating and fixed charges on the equipment and continuity of operation. An air-cooled Herreshoff furnace has been adapted to this purpose. Analyses for total sulphur, sulphur as sulphate, and sulphur as sulphide indicate the mechanism of the combustion. Part of the sulphur of the pyrite is volatilized on heating, but the rate of combustion of the residual iron sulphide is about equal to the rate of sulphur evolution, so that at no time is any very large quantity of sulphur present as sulphide. Sulphate formation does not occur above 600 deg. C., so that it is desirable that the ore be held above this temperature for a sufficient period of time completely to remove the sulphur as sulphur dioxide. To make this possible it is necessary to slow up the initial combustion reaction so as to distribute sulphur removal more evenly.

Variation of Temperature and Sulphur Content of Pyrite in Passing Through Herreshoff Furnace (Test Run No. 3)



FIBER TO TEXTILE—

By Way of the Unit Operation

By RICHARD G. KNOWLAND

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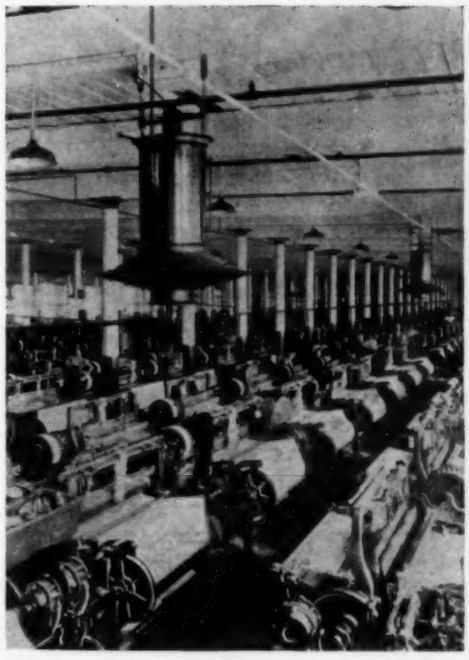

Well Advanced Mechanically, as the Author Says, the Textile Industry Needs to Adopt More Chemical Engineering Methods. The Overhead Humidifiers in This Weave Room Are Already General Practice

IN ANY DISCUSSION of the textile industry, one is immediately struck with the contrast which it presents to what we may term industries of modern origin. Textile methods in general were conceived many thousands of years ago and the arts of weaving and dyeing were well established centuries before technical methods or technically controlled processes became available. The textile industry also embraces much of craftsmanship as well as art. Since these elements are of foremost importance in making merchantable fabrics, it was not until recent years, when the urge of competition forced the use of more economical methods and the acquiring of hitherto unattainable effects, that a really scientific and technical background began to develop. In these respects, textiles share with the potter's art and the leather industry the distinction of having added engineering and chemical methods as afterthoughts, instead of having developed as a result of them. Unless these facts are clearly borne in mind, the industry is likely to be put in a false light when its status from a scientific and technical standpoint is compared to that of any industry developed during the last century.

As to the functions of the chemist and engineer in textiles, their efforts have resulted in profound changes in these classes of operations: (1) Preparation of fibers for processing; (2) bleaching; (3) dyeing fibers, yarns, and fabrics; (4) printing; (5) finishing fabrics to confer useful and attractive effects; (6) development of new dyes and chemicals; (7) development of synthetic fibers; (8) evolution of suitable testing methods.

Since time does not permit any description of textile operations sufficient to afford a background, we shall have to plunge directly into a description of those general classes of textile operations which are affected by chemical engineering efforts and limit the details of operations peculiar to textiles so far as possible.

Mechanical Conveying

Textile materials are conveyed in pipe lines by air, on belt-type conveyors, and by tractors. In the handling of raw wool or cotton fibers which have not been fabricated into yarn, air pipe lines are invariably used for all long-distance conveying about the plant. Such distances may run up as high as 3,000 ft. The air velocities required for cotton or wool vary from 30 to 50 ft. per sec., depending on conditions. Boosters are often employed on very long pipe lines, where the losses from friction become excessive. Wet cotton may be conveyed by air, but wet wool of long staple cannot be thus handled, because of its tendency to snarl and plug the line. Wet wool usually is conveyed by truck, with or without trailers, or by belt conveyors.

Cotton is carried for short distances by belt conveyor. A typical case is in the bottom picker room, where a single belt conveyor with gates properly located in side walls which inclose the belt are arranged automatically to shunt the proper quantity of fiber as required into the feed box of any one of a battery of machines. Bobbin boxes and packages of yarn or laps are frequently transferred from one department to another by belt conveyor.

Since modern textile plants are highly departmentalized, because of the necessary lack of continuity in the manufacturing processes, the interdepartmental use of tractors and trailers for process or finished goods is common. This naturally is true of the larger plants in particular. In silk manufacturing, where the volume of materials so requires, use is made also of belt conveyors and of tractors.

In general, while the art of conveying textile materials is well enough developed, only a relatively limited number of mills are employing as economical conveying methods as they might. The cost of this operation, if fully allowed for, may be expected in an average mill to amount to about 2 per cent of the total cost of produc-

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tion. In stating such figures, by the way, for so varied an industry and for units of widely divergent size, it should be understood that only an average figure is being attempted. In a large mill, however, the total annual bill for conveying materials is likely to run up to $200,000.

Drying Problems and Methods

There are so many appliances of drying in the textile industry that it seems wise to classify them as follows:

1. Raw or dyed fibers.
2. Yarn in (*a*) single strands, (*b*) skeins, (*c*) packages.
3. Cloth while (*a*) slack, (*b*) under lateral and longitudinal tension.

Before wool can be processed, it must first be "scoured" in alkali and soap to remove the grease and attendant dirt, after which it must be dried. Cotton which is raw-stock dyed must also be dried in fiber. The method generally employed for drying such fibers is to distribute a uniform lap of the materials over a screen which travels through a dryer housing. In many cases several such screens are employed; in each case an upper screen discharges its lap onto the screens below, which travel in reverse directions with respect to each other. Such dryers usually are heated by steam coils arranged at the side in boxes and circulation is provided by fans which withdraw air from the top of the dryer, pass it through the coils and then across the bottom of the dryer, whence it is drawn upward through the screens carrying the fibers under treatment. Saturated air is extracted near the feed end of the machine and at the top. Automatic regulation ordinarily is not provided, although it should be. The degree of engineering skill lavished on most of these contraptions deserves little in the way of comment. One or two dryer manufacturers are now furnishing dryers, however, which afford a heat efficiency in terms of pounds of water evaporating per pound of steam of about 65 to 70 per cent. The average "raw-stock dryer," as encountered in most mills, has been found not to be good for over 45 per cent.

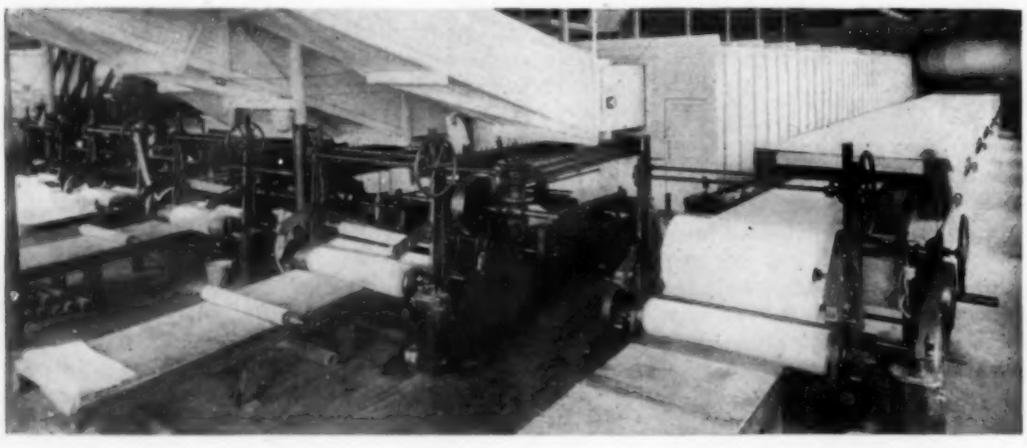
The chief limiting factors in raw-stock dryer design include a temperature not to exceed approximately 170 deg. F. for wool and not over 210 deg. for cotton if the fibers are discharged bone dry. If these temperatures are passed, wool is rendered harsh and yellow and cotton weakened in breaking strength. Wool should actually be discharged from the dryer with 8–12 per cent of regain and cotton with 6–8 per cent. Consequently, in a properly designed and regulated dryer, taking advantage of the fact that the materials do not heat above the wet-bulb temperature within the dryer, and that the above final regains are required, the actual operating dry-bulb temperatures within the dryer may be considerably above 210 deg. for either wool or cotton; and this without injury to the fiber.

A vast amount of work remains for the chemical engineer in the way of revamping the innumerable inefficient raw-stock dryers in use or in designing more economical ones.

Skein dryers are similar in general external form to raw-stock dryers. The skeins, however, are placed on poles which fit into chain conveyors and are then carried through the drying chamber. The circulation is provided from top to bottom by units of fans and the heating elements are located at the side or overhead. The better operated machines provide a gentle countercurrent flow of air up the dryer and for exhausting the correct amount for most efficient operation. Some of the skein dryers as developed by two manufacturers in particular are capable of extremely efficient operation. In both cases, the material is dried well under the desired regain and then "conditioned" back in the final sections of the machine.

Temperature limitations are the same as for raw stock. The air velocity in recirculation is important if tangling of the skeins is to be avoided. The limiting circulation velocity employed depends strictly on the density of packing, because of this tangling effect. In skein drying, the factor of diffusion time must be allowed for, since the thickness of material in the bunches of yarn complicates the problems beyond that of the mere circulation of air. It might be said that engineering principles have been recognized throughout in the design of the newer dryers. They are commonly used for rayon, silk, cotton, and wool.

The drying of yarns in packages such as cops, cheeses, or on perforated beams is a gradually increasing practice. With the advent to common use of dyeing machines which force the dye liquor back and forth through such packages, drying methods naturally have evolved to permit unwinding a dyed and washed yarn in the dry state. These dryers usually are of the chamber type with the packages on racks or trays placed on trucks. In this problem, where diffusion time is the paramount factor and the matter of removing the moisture, as it diffuses to the surface, very simple, this type of dryer has proved efficient when properly designed. In some package dyeing machines, subsequent to the aftertreatments and washing processes, hot air is forced through the packages as a means of drying. This practice is not general, however, and because of the high pressures required, is

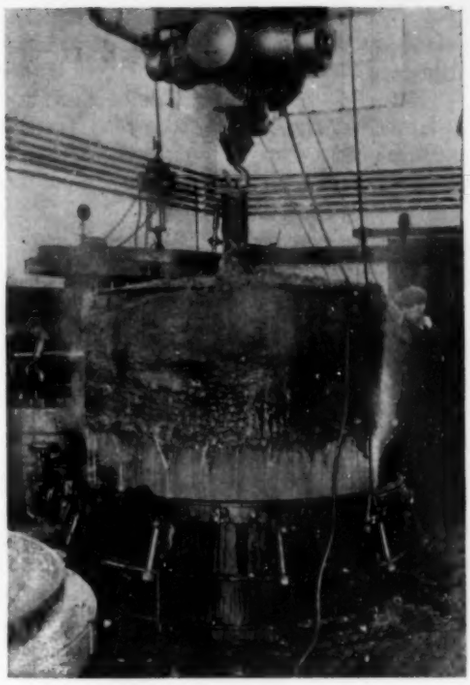


Heating Ducts and Two Types of Housings Are Seen on These Tenter Dryers

not economical. Rayon, silk, wool, and cotton are all frequently dried in the package.

Yarn dryers are commonly used in which single strands are led in sheets over drying cells, dry-cans or cylinders, or are looped through continuous, "hot-air" dryers. The over-all steam efficiency in all except the loop dryers will run up to 80 per cent where cans or cells are well covered with the sheet of yarns and where other possibilities of heat loss are provided against. Good control and a well-designed dryer are required to attain a heat efficiency of more than 45 per cent in a loop dryer, although up to 70 per cent can be gained with careful control. Loop-drying obviously provides a softer and loftier yarn, desirable in certain fabrics.

Cloth is dried in the slack form in loop dryers. Generally, it is dried on cans or in the so-called tenter-frame. In the tentering operation a group of dry cans is employed first to reduce the moisture content in the cloth to from 15 to 30 per cent of regain. The cloth then is seized automatically at each selvage in the jaws of the tenter-chains and drawn horizontally through a drying tunnel. Circulation of air usually is countercurrent and a series of high-velocity jets of hot air are often employed throughout the length of the tunnel to force the drying medium through the pores of the cloth. The tenter chains gradually spread in the passage through the tunnel, becoming parallel about halfway through. While thus held and dried stretched, the cloth assumes its permanent "set" to the desired width. To maintain this "set" accurately, the cloth at exit should carry not over 4–6 per cent of regain. The steam efficiency of the average tenter housing is about 15–25 per cent. Consequently, good practice requires that the dry cans which precede the tenter should perform as much of the entire drying operation as will leave the cloth extensible enough for the final stretching and drying in the tenter itself.



Wool Stock Emerging From Dyeing Bath

Humidity Control Requisite

In the textile industry the humidification of rooms in which manufacturing operations are carried on is general. Cotton requires an atmosphere of at least 50 per cent relative humidity for good picking, 60 per cent for carding, 60–75 per cent for spinning, and 65–85 per cent for weaving. Woolen and worsted fibers pick and spin better when humidified; 50 per cent relative humidity is desirable. Woolen operations, however, are not so sensitive to variations in humidity as are those on cotton. In the cotton industry, a drop in relative humidity of 20 per cent has been known to increase warp breakage in weaving to an extent sufficient to cut in half the number of looms which were being operated per weaver. Silk and rayon operations also require a steady and controlled humidity. In the manufacture of rayon, from the time it leaves the spinneret, controlled humidity of about 60 per cent relative is required.

The functions of humidity are to prevent static, to reduce "fly" on the yarn, to increase breaking strength, to increase elasticity, and to decrease losses in the "invisible waste" which results from the snapping of dry and brittle fibers. As suggested specifically in the case of cotton, each operation works best at some perfectly definite relative humidity.

The function of atmospheric humidity is, of course, to establish on the fibers that percentage of regain most favorable to the particular operation at hand. Variations of more than plus or minus 5 per cent relative are detectable in their effects on nearly all textile operations where the regain is a factor. Closer regulation is desirable. Consequently, the regulation of room humidity must be absolutely automatic. The types of regulators employed include those which are membrane operated, and many types of wet- and dry-bulb instruments. Hygrometric controls are, of course, valueless. The sensitivity of control depends on the equipment available (its type and distribution of outlets and their capacities) as well as on the kind of building involved, on the distribution of the machinery, and on the number and locations of the regulators.

In the manufacture of rayon, central-station equipment is generally used. In this system air is drawn through a spray chamber in which the temperature of the spray water is so regulated as to confer the desired dew point on the air. Fans then supply the saturated air to the respective rooms.

By the use of volume dampers and steam coils, both automatically regulated by dry-bulb controls, very accurate humidity conditions at a reasonable dry-bulb temperature can be maintained for each room, even though a different relative humidity is required for each room. The air, after circulating about the room, returns in ducts to the central station, where the necessary quantity is rejected and sufficient fresh air drawn in to maintain a fixed temperature-humidity balance in the mill. This type of equipment is frequently found also in cotton mills. From four to five air changes per hour are general in this practice.

The unit system, so-called, is gaining headway. This "unit" is really a small central station with sprays, heaters, fans, and regulators. Several units may be placed on a large floor. The humidified air is discharged well above the floor at high velocity, entraining a large volume of room air as it travels from the unit. A major advantage in the unit system lies in the ease with which units are added or removed if the operations in a given department are changed.

The so-called "head types" of humidifying equipment include two chief varieties. In the first group are those known as turbo heads, in which a jet of air ejects a fine mist of water into the room. In the second type an electric motor drives at high speed a disk on which falling

water is broken up into a fine mist. This type of equipment has a relatively high capacity and is employed where the headroom is considerable. The turbo type works well for either high or low headroom, but is especially adapted to the latter instance. The large majority of textile plants employ some make of head-type equipment. In all cases where good operating methods are required, automatic regulation is installed. The equipment is of relatively little use otherwise.

Incidental Unit Operations

The use of evaporation in the textile industry is rare. In the case of large cotton mercerizing plants, however, where the consumption of caustic soda is sufficient to justify it, evaporators are employed. Customarily, they are either triple- or quadruple-effect.

Refrigeration is another chemical engineering process which is rarely required in textiles. In cotton mercerizing, refrigerated caustic soda solutions are employed in some plants. The effect obtained is somewhat different from that derived when warmer caustic solutions are used. The concentration of alkali required for a given effect drops rapidly as the temperature is lowered.

An interesting instance of the use of refrigeration is found in the Heberlein process for the low-temperature treatment of cotton cloth with caustic soda. In this process, cotton cloth assumes a permanent linen-like effect which cannot be destroyed even after repeated washing and long wear. The temperatures employed are far below those for a so-called low-temperature mercerization.

There are in the textile industry no problems involving the flow of heat which are not similar to those encountered elsewhere. The same may be said in regard to the flow of fluids.

The recovery of heat from waste dye or boil-off liquors is determined upon and, if necessary, put into effect by the use of interchangers, as in other industries. It might be said, however, that textile mills as a whole are wasteful of hot water and that the use of heat interchangers is not so general as it should be. Of course, it is common practice to float automatically regulated hot-water reservoirs on the boiler lines to care for peak loads; and all well-run mills which require much process steam utilize bleeder turbines or their equivalent. The cost of coal and power is very heavy in textile operations and much work along engineering lines remains to be done for nearly all the smaller units.

Where Improvements Are in Order: Kier Room for Boiling Out Cotton Before Bleaching

More Work for the Engineer

It is somewhat venturesome to attempt to lay out the fields in which scientific and engineering work appear to be needed in the textile industry, but a few of these are listed below:

1. An economical method of recovering wool-grease residues from scouring liquors. At present the only useful byproduct is lanolin, which enjoys a most restricted market. The value of the residues for fertilizer does not repay the cost of recovery under present methods. Legislation against stream pollution, however, may force this issue without regard to economics.

2. Work should be done to determine whether useful byproducts cannot be derived from wool scouring residues. At least 150,000,000 lb. of such residues are annually discharged to waste in the United States.

3. The dyeing of cotton wool, rayon, or silk in the piece is generally a rapid process. Dyeing yarn and raw stock are time-consuming processes. Means for speeding up the dyeing cycle for yarns and raw stock would result in very large economies.

4. Quicker means than those generally employed for boiling-off cotton cloth before bleaching and dyeing should be introduced. Removal of the waxes and gums natural to cotton fibers and of motes must be accomplished in order to assume even bleaching and dyeing. Common practice is to "boil" the cloth or yarn under pressure in kiers holding up to 10,000 lb. of material for from 4 to 16 hr. The chemicals used are soda ash, with or without soap, or "soluble oils" as assistants. Trisodium phosphate also is used. The general use of a good continuous process to replace the cumbersome and costly kier-boiling is greatly to be desired.

5. A good continuous dyeing process for all raw-stock fibers would be advantageous. Only one such machine has ever been made to work successfully and this has so many difficulties connected with it that its use can hardly become general.

The above represent a few general suggestions as to problems requiring attention. On dyestuffs, chemicals, and new processes or finishes, the most important problems are chemical. Chemical engineering control, however, to a greatly increased degree would result in major economies in nearly any mill and on any of the above items. The textile industry as a whole is well advanced mechanically, but by no means is this true chemically or from the viewpoint of the chemical engineer. Rule-of-thumb methods prevail very largely, especially in the manufacture of woolen and silk products.

An Explanation of

What Happens During Cracking Of Petroleum Hydrocarbons

By PER K. FROLICH

Assistant Director of Research Laboratories
Standard Oil Development Co.
Elizabeth, N. J.

EDITOR'S NOTE: *Here is a remarkably clear picture of the mechanism of petroleum cracking. Later this unique discussion will be elaborated as a chapter of a book in the Chemical Engineering Series on "Chemical Principles of High-Pressure Processes." Republication rights are reserved by the author, but comment, criticism, and further discussion will be heartily welcomed.*

CRACKING is the term commonly used for the thermal decomposition of hydrocarbons, particularly as practiced in the refining of petroleum. The purpose of the cracking operation is primarily to increase the yield of low-boiling constituents by breaking down the larger molecules present in petroleum. Although the chemistry of cracking is complicated and not thoroughly understood, it is definitely proved that the controlling factors are rate of reaction and equilibrium phenomena.

Chemical Composition—The types of hydrocarbons present in petroleum vary with the origin of the crude oil, but in all cases the lower fractions consist of paraffin hydrocarbons ranging from methane upward. The intermediate cuts are partly paraffins and partly single-ring naphthenes, while the heavier components consist largely of single and condensed rings with paraffinic side chains of varying length. Although simple paraffin hydrocarbons of high molecular weight are found in considerable amounts particularly in the so-called paraffin base crudes, Mabery's work has shown beyond doubt that the greater portion of the paraffinic constituents exist as radicals linked to ring compounds, the rings being either naphthenic or aromatic in character. As far as is known, olefins and diolefins are not found in the original crude.

Analyses of various types of crude oils show that they contain on the average two atoms of hydrogen, or slightly less per atom of carbon. Actually, the ratio of hydrogen to carbon is higher in the lighter fractions (as exemplified by the lower paraffins: C_nH_{2n+2}), but decreases gradually as the molecular weight rises. The hydrogen content of the high-boiling fractions therefore is considerably lower than the average 2:1 ratio. This progressive decrease in the hydrogen-carbon ratio with increasing boiling point is an important factor in the cracking and hydrogenation of petroleum.

Thermodynamic Stability—With the exception of methane, and possibly ethane, all petroleum hydrocarbons are inherently unstable, thermodynamically speaking, at temperatures above about 200 deg. C. Below this temperature, however, the rate of reaction is so slow that practically no decomposition occurs, even of the most complex and unstable molecules. As the temperature increases the hydrocarbons become thermodynamically more and more unstable, but the temperature coefficients vary for the different series (Francis and Kleinschmidt, *Oil and Gas* Journal, Vol. 28, p. 118 [Dec. 5, 1929]; Am. Petr. Inst., Vol. 11, p. 93 [1930]). Thus, while at low temperatures aromatics are as a rule less stable than paraffins, the order is reversed in the range of 300 to 500 deg. C. From somewhat below 400 deg. C. and up there is, consequently, an increasing tendency for the formation of aromatics from paraffins, although any aromatics thus produced are themselves unstable and tend to decompose further into methane, carbon, and hydrogen.

The only simple hydrocarbon whose stability increases with rising temperature is acetylene (and probably its homologues). However, the indications are that this is of little importance as far as most of the present cracking processes are concerned, because the free energy relations are such that acetylene apparently is not formed to any appreciable extent at the temperatures involved.

Such thermodynamic considerations lead to the important conclusion that, under the conditions of temperature and pressure ordinarily employed in practice, the cracking of a hydrocarbon into two smaller hydrocarbon molecules is a non-reversible process. On the other hand, reactions involving liberation of hydrogen only are frequently of the reversible type. Examples are the formation of aromatics by removal of hydrogen from naphthenes and the liberation of hydrogen from a paraffin to form an olefin with the same number of carbon atoms. Depending upon the conditions of temperature and pressure employed, it is thus possible not only to convert naphthenes into aromatics by dehydrogenation but also to hydrogenate aromatics into naphthenes by the reverse reaction. Likewise, paraffins may yield olefins, or olefins may be converted to saturated compounds. In general, the dehydrogenation step is counteracted by pressure, and particularly so in the presence of hydrogen. Another rule is that the temperature theoretically required for hydrogen to split off, decreases with increasing molecular weight in a given series of hydrocarbons.

Actual Stability—Aside from the fact that free energy relations determine whether a certain type of reaction is

at all possible, the particular transformations which take place in the cracking of petroleum are largely governed by relative reaction rates.

Experience has shown that in the temperature range covered by liquid-phase and vapor-phase cracking, roughly 400 to 600 deg. C, the various series may be listed as follows in order of decreasing tendency to crack. This comparison is based on compounds of equal molecular weight.

1. Paraffins ..... $C_n H_{2n+2}$ (straight chains)
2. Olefins ..... $C_n H_{2n}$ (straight chains)
3. Diolefins ..... $C_n H_{2n-2}$ (straight chains)
4. Naphthenes ..... C_nH_{2n}, C_nH_{2n-m} (*) (rings)
5. Aromatics ..... $C_n H_n$, C_nH_{n-m} (*) (rings)

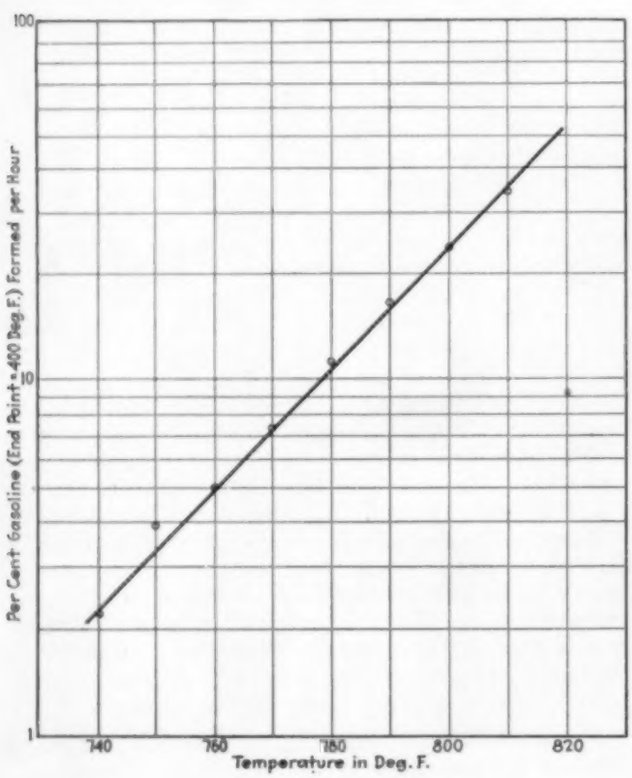
(*) Indicating condensed rings.

Except in the case of naphthenes, the stability of the higher members of any given series increases by and large with decreasing ratio of hydrogen to carbon in the molecule. Furthermore, it has been found that side chains are in general more stable than the ends of straight chains.

What is being said here about the relative stability of hydrocarbons refers strictly to the temperature range specified: i.e., approximately 400 to 600 deg. C. At higher temperatures, 600 to 700 deg. C, or perhaps even lower, diolefines become more stable than naphthenes. Thus it is possible by cracking at such high temperatures to convert naphthenes into diolefins, which in turn may give aromatics by subsequent polymerization and liberation of hydrogen.

Character of Cracking Stock—The methods of handling the crude oil vary widely in different refineries and are determined by the character of the stock as well as by the particular type of equipment employed. As a rule, however, the lighter ends, constituting the natural gasoline content, are "topped off." The remainder may either be cracked directly or the burning oil and lubricating oils may first be separated. In the latter case the cut between kerosene and lubricating oils ("gas oil") serves as the cracking stock.

Fig. 1—The Effect of Temperature on the Rate of Cracking of Gas-Oil



Primary Cracking Reactions—As the temperature of these complex hydrocarbon mixtures is increased in the cracking process, noticeable decomposition usually begins to occur somewhat above 300 deg. C. It will readily be understood, however, that the point of incipient cracking is dependent not only upon temperature but also on the nature of the most unstable hydrocarbons present in the charge. The rate of cracking is a function of temperature and doubles approximately every 10 deg. C. (18 deg. F), as shown by the data of Humphrey et al (U. S. Pat. 1,553,861; 1925), plotted in Fig. 1. The initial molecular breakdown has commonly been considered a first order reaction, independent therefore of concentration.[1]

From what has already been said above concerning the relative stability of the various groups of hydrocarbons, it follows that straight chains break first. The point of break seems to follow the law of chance, but at temperatures below about 450 deg. C. is nearly always between carbon atoms, so as to produce one saturated and one unsaturated molecule, as exemplified by

$$\underset{\text{Saturated}}{R.CH_2.CH_2{-}CH_2.CH_3} = \underset{\text{Saturated}}{R.CH_3.CH_3} + \underset{\text{Unsaturated}}{CH_2{:}CH.CH_2..CH_2CH_3}$$

On further cracking these new molecules may breakdown into still smaller units. In that case the saturated molecule undergoes the same change as before. The olefin resulting in the above example may give either two new olefins or one paraffin and one diolefin molecule, but the indications are that splitting into two olefins is the predominating reaction, at least at the lower cracking temperatures. Naphthene rings may likewise split to form olefins.

The higher the temperature the greater is the tendency for hydrogen to split off. In this way aromatics are produced from naphthene rings by cracking at about 450 deg. C. and upward. Removal of hydrogen from a paraffin molecule results in an olefin of the same number of carbon atoms. As the temperature increases above 700 deg. C. more or less complete breakdown of the larger sized molecules occurs, characterized by excessive formation of coke and hydrogen. Due to the rapid rate of destruction, it is difficult, however, to distinguish between primary and secondary reaction products. At these higher temperatures acetylene begins to appear.

Polymerization and Recracking—From the above it follows that unsaturated compounds invariably are formed as part of the products resulting from the cracking of hydrocarbons. These unsaturated molecules, particularly the larger ones, polymerize readily and in this way there are produced new compounds whose molecular weight tends to exceed that of the original stock. It is important to note, however, that the unsaturated molecules possess less hydrogen per carbon atom than the original hydrocarbons from which they are derived,

[1] Although it has been shown conclusively by Kiss (*Ind. Eng. Chem.* Vol. 22, p. 10 (1930) that the law for monomolecular reactions applies to this process, data recently obtained by Schneider and Frolich (*Ind. Eng. Chem.*—in press) indicate that the first step in the cracking process may be more complicated than hitherto realized. For example, a careful study of the cracking of the simpler paraffins and olefins has shown that primary reactions of the following type occur to a considerable extent:

$$2C_2H_6 \longrightarrow C_2H_4 + C_2H_{10}$$
$$2C_2H_6 \longrightarrow C_2H_4 + C_2H_6$$
$$2C_2H_4 \longrightarrow C_4H_6 + H_2$$

While at first sight bimolecular, these reactions nevertheless behave approximately monomolecularly and consequently obey the mathematical analysis of Kiss.

and that consequently the same holds for the polymerization product. On prolonged exposure to high temperature, the polymerized material suffers recracking with the formation of new unsaturated bonds, which again give rise to further polymerization.

Progressive reactions of this type lead to the formation of more and more complex compounds of decreasing hydrogen-carbon ratio, and with this decrease in hydrogen content the material becomes more and more refractory; i.e., resistant to temperature (*cf.* previous discussion of stability). The final products are therefore: (1) gaseous and low-boiling liquid compounds relatively high in hydrogen, and (2) liquid material of high molecular weight, tar and petroleum coke, possessing a low ratio of hydrogen to carbon.[2] This is illustrated in a qualitative way by Fig. 2. (Strout, *Ref. and Nat. Gas Mfr.*, Vol. 8, No. 12, p. 64 (December, 1929)), which shows the changes taking place as the cracking progresses.

Hence, it is seen that the complete cracking process is a sequence of decomposition and polymerization reactions, the character of the final products being determined largely by the nature of the hydrocarbons present in the original cracking stock, by the temperature and pressure of operation, as well as by the time of exposure to cracking conditions. Polymerization is a bimolecular reaction and its rate therefore is under parallel conditions, proportional to the square of the pressure; the rate of polymerization increases with temperature but apparently much less rapidly than the rate of simple molecular breakdown. If the temperature is high and the pressure low, there is a tendency for polymerization to take place with simultaneous liberation of hydrogen. By increasing the pressure, however, the hydrogen evolution is counteracted.

This effect of pressure on polymerization has been demonstrated in unpublished experiments by the writer and his co-workers with ethylene and propylene. At atmospheric pressure a large amount of hydrogen is evolved and benzene is formed in good quantities together with other high boiling materials. There is little evidence, however, of any non-aromatic products. If now the pressure is raised gradually while the temperature is kept constant, less and less hydrogen is liberated and the product loses more and more of its aromatic character, until at a pressure of several thousand pounds the liquid material formed is decidedly non-aromatic, even when the temperature of the reactor is maintained as high as 600 deg. C.

Vapor-Phase and Liquid-Phase Cracking

Petroleum hydrocarbons may be cracked either in the vapor phase or in the liquid phase. Vapor-phase processes usually are operated at temperatures of the order of 600 deg. C. at atmospheric pressure or somewhat higher. In the so-called liquid-phase cracking the pressure ranges from a few hundred pounds upward to one thousand pounds per square inch at temperatures of, roughly, 400 to 500 deg. C. In this range the low boiling hydrocarbons are above their critical temperature, while only those of relatively high molecular weight are below, and it therefore follows that considerable pressure is needed to give a true liquid-phase system by solution of the lighter ends in the liquefied heavier ends. The higher the temperature, the higher the pressure required to accomplish this. However, in many of the processes ordinarily referred to as "liquid-phase," the pressure employed is not sufficiently high to prevent a substantial portion of the cracked products from accumulating as vapor.

The properties of petroleum hydrocarbons discussed in the previous sections lead to the obvious conclusion that vapor-phase cracking, operated at low pressure and short time of contact, does not particularly favor polymerization and recracking, with resulting coke formation. This is illustrated by the fact that both the gaseous and liquid products from vapor-phase cracking may contain as much as 50 per cent of unsaturated compounds.

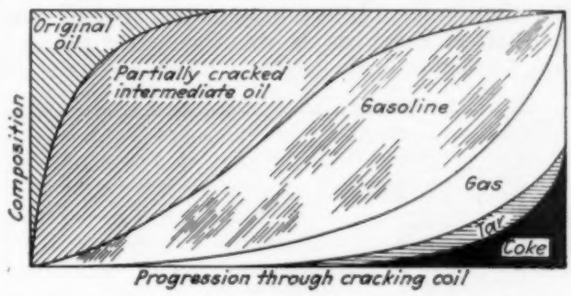


Fig. 2—Degree of Tracking as a Function of Time of Contact

As the pressure on the cracking unit goes up, polymerization and coke formation increase, at first very rapidly, then more and more slowly until finally coke production passes through a maximum and again decreases with further rise in pressure. This peculiar result may be explained when it is recognized that with rising pressure there is a gradual change from a true vapor-phase system into one containing increasing quantities of liquid. Since simple polymerization is a bimolecular reaction, its rate increases theoretically with the square of the partial pressure of the unsaturated compounds, and therefore in the beginning approximately with the square of the total pressure on the system. However, as the pressure continues to rise, the cracked products will be condensed out and dissolved in the liquid phase in increasing quantities. In this way the unsaturated compounds of high and medium molecular weight, which are the ones that polymerize most readily, are kept out of the vapor space and remain in the liquid phase, where dilution with the cracking stock slows down the rate of polymerization. With rising pressure the progressive polymerization and recracking reactions, which according to the previous discussion lead to products of gradually decreasing hydrogen-carbon ratio and eventually to the formation of petroleum coke, are therefore at first accelerated, until their rate passes through a maximum, and finally decreased. Although polymerization and recracking still takes place, such secondary reactions are at ordinary cracking temperatures greatly depressed at 600 to 1,000 lb., as compared with, say, 100 to 200 lb. pressure.

Because of the high temperature and low pressure employed, the vapor-phase product is rich in aromatics, and it also stands to reason that a larger percentage of the original stock must be converted to gaseous products in vapor-phase cracking. In comparison, the yield of unsaturateds and the gas losses for a given stock ordinarily are low when the cracking process is operated in the liquid phase.

In order to control polymerization and recracking in the liquid-phase process, it is best from a chemical standpoint to reduce the time factor by removing the products

[2]Note that petroleum coke is not elementary carbon but consists largely of exceedingly complex hydrocarbons of high molecular weight and a low ratio of hydrogen to carbon. This is proved by chemical analysis and by the fact that 50 to 80 per cent of the material is soluble in carbon bisulphide.

after reaction has progressed to a reasonable extent. The residuum after this operation, which has a lower hydrogen-carbon ratio (*cf.* above) and hence is more refractory, should be subjected to more vigorous conditions than the original stock. In practice, however, the residue usually is recycled, due to the mechanical ease of such a procedure. The increased formation of aromatics resulting from operation of liquid-phase cracking at higher temperature is desirable because it reduces the knocking tendency of the gasoline; however, with excess production of aromatics the gasoline yield decreases materially, becoming less and less with rising temperature, while coke and gas formation increases.

The high percentage of unsaturated compounds in vapor-phase cracking has the disadvantage of giving rise to gum formation in the engine. To counteract this the losses in treating the gasoline must necessarily be heavy. The olefins and aromatics formed in large quantities at the high temperatures employed in vapor-phase cracking on the other hand, are desirable from the point of view of knock rating. Although it has been assumed in the past that the tendency to produce detonation decreases in the hydrocarbon series in the following order: (1) paraffins, (2) olefins, (3) naphthenes, and (4) aromatics, the indications now are that the influence of molecular structure is so marked as to outweigh the effect attributed to the various series (Lovell, Campbell, and Boyd, *Ind. Eng. Chem.*, Vol. 23, p. 555 (1931)). Hence, considerable overlapping may occur when the comparison is based on individual hydrocarbons. In general it is found that branched hydrocarbons are better knock suppressors than straight chains.

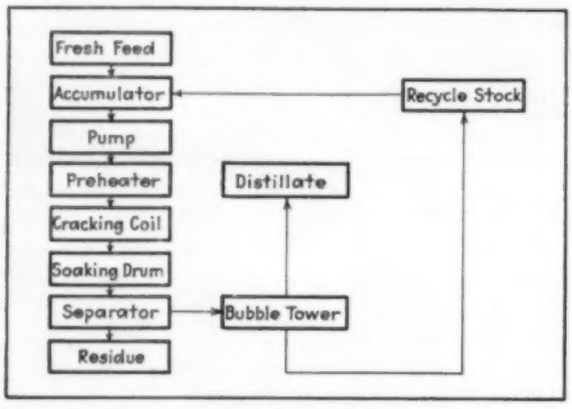


Fig. 3—Typical Flow Sheet of a Liquid-Phase Cracking Unit

Operation of Cracking Processes

The first commercial use of cracking was to increase the yield of kerosene by distilling slowly and refluxing heavily during that part of the distillation in which the kerosene fraction came over. As far as production of gasoline was concerned, this method had the disadvantage that, since it operated at atmospheric pressure, only the heavy ends were cracked. Cracking to gasoline was greatly improved by the invention of the Burton still, which, as later modified by Clark, consisted of a steel shell with tubes for heating surface and was operated under pressure. To reflux the higher boiling constituents which vaporized with the cracked product, the Humphrey tower and other condensers were devised. This method had the disadvantages of low capacity and operation with undue coke formation in the heating tubes, since the limited amount of circulation permitted the heavier products to segregate in the bottom of the shell where the tubes were located. The construction of the shell did not permit the use of very high pressure.

In modern liquid-phase operation the tendency is to carry out the bulk of the cracking separate from the heating unit. The charging stock is heated in tubes ("cracking coils"), where it is not allowed to remain long enough for cracking to progress beyond the primary stage. It is then run into a tank or drum ("soaker"), where it is given sufficient time for the cracking to continue to the desired point, as indicated by the flow sheet in Fig. 3. On release of the pressure, the low-boiling products and tar are separated from the intermediate portion, the latter being recycled. Although low pressures of about 200 lb. are still in wide use, the more recent practice is toward increased pressure, extending up to 1,000 lb. As pointed out above, pressure reduces coke formation in the drum by keeping the unsaturated compounds diluted in the liquid phase. The best means of preventing coke formation in the tubes is to employ high velocity of the feed stock. This prevents secondary cracking by not allowing time for it to take place. Also, by increasing the velocity, the temperature may be increased, thereby increasing the capacity of the equipment, due to the higher reaction velocity.

The tendency is toward operation at higher temperature in liquid-phase cracking for the purpose of improving the anti-knock quality of the product by increasing the yield of aromatics and possibly branched chain compounds. For the same reason, there is at present an increasing interest in the development of true vapor-phase processes operating at very low pressures.

Acknowledgment: This article embodies ideas which to a large extent have been contributed by others. The writer is particularly indebted to W. K. Lewis, G. M. Maverick, and P. L. Young for many of the interpretations given in the course of the discussion.

▼ ▼

Cracking Waste Gases to Produce Aromatics and Olefins

THE present trend toward high anti-knock motor fuels emphasizes the possibilities for the production of aromatic and olefin hydrocarbons from natural gas. Such a process is particularly attractive to the petroleum refiner, for it would offer an outlet not only for excess natural gas but also for such other waste gases as that vented from natural gasoline stabilizers, excess butanes in casinghead, and heavy refinery vapors.

In this connection some interesting semi-plant scale experiments are reported by Walter J. Podbielniak, research chemical engineer of Tulsa, Okla., in an article in the May 19, 1931, issue of *The Oil & Gas Journal.* These show yields of benzol and heavier aromatics as high as 2.7 gal. per M. cu.ft. of stabilizer vent gas of 1.5 sp. gr. accompanied by twofold increase in volume of raw gas. Under different conditions 600 cu.ft. of ethylene plus 1.1 gal. of aromatics are obtained per M. cu.ft. of raw gas, accompanied by a 50 per cent increase of gas volume. Similarly, butanes would show yields and expansion ratios about 30 per cent higher.

The experimental plant used by Podbielniak consisted of a continuous tube-type furnace, using a single tube coil of heat-resistant alloy having a capacity of about 25,000 cu.ft. per day. Operating temperatures as high as 1,650 to 1,750 deg. F. were employed, thus introducing a serious problem in refractories and construction materials.

Mutual Production Interests Engage GAS AND OIL INDUSTRIES

By R. S. McBRIDE
Assistant Editor, Chem. & Met.

PETROLEUM, natural gas, and manufactured gas are daily being forced into closer technical relations and confronting common management problems as a result of new gas-making methods. This is the outstanding development in the industries as demonstrated at the production conference of the American Gas Association, May 20-22, at Philadelphia, Pa. Furthermore, it is a development of outstanding importance to users of industrial gas in all sorts of process industries, because the consequence is the supply of fuel for industrial heating with improved service or at lower cost.

This important development should not be regarded as altogether surprising, for *Chem. & Met.* has emphasized its possibility on numerous occasions, particularly in January, 1930, when the magnitude of available gaseous-fuel supplies from the petroleum industry was stressed. It was then pointed out that petroleum refineries were a potential source of city-gas supply still practically untouched, but capable of furnishing more gaseous energy than is currently supplied by coke ovens for this use. The conditions, then, favoring the utilization through public-utility systems of petroleum-refinery byproduct gas are today much more favorable; and the recent gas conference program has demonstrated the practicability of these sources of gas in several localities.

NATURAL GAS, which during the past two or three years has invaded the public-utility field, does not now promise complete displacement of other city supplies to anything like the extent which at first seemed likely. Mixing of natural gas with manufactured gas, as practiced in a number of localities, seems a more likely development for a large number of communities, some of which have already successfully practiced it. And some of the communities from which reports were received at the conference have successfully handled mixtures of coke-oven gas, refinery gas, and water gas or producer gas, or refinery gas, coke-oven gas, and natural gas—in fact any type of fuel-gas mixture.

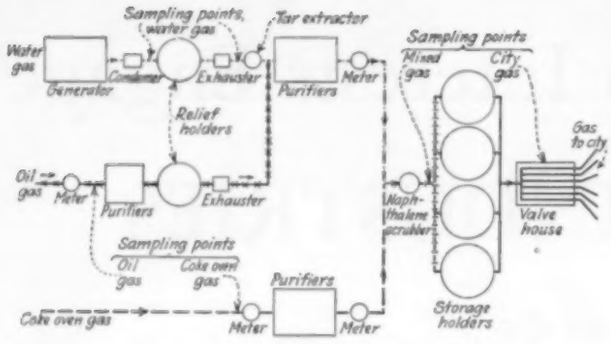
Even those companies which have retained the more nearly conventional system of water-gas making are now frequently utilizing heavy fuel oils, such as "Bunker C" grade oil, as a carburant. Thus the gas industry affords a new outlet to the petroleum man for his less valuable fuel oils, permitting the use as cracking stock in the refinery of the lighter grades which formerly were demanded as gas oil by the utility-company engineer.

Economic as well as technical considerations, of course, enter to determine for any individual gas how far or how fast these various trends can progress. The conference afforded for the first time rather comprehensive information enabling engineers to appraise these developments with practical works-scale experience as a guide. Particularly important for this purpose were the papers presented under the auspices of the water-gas committee at a symposium on handling, mixing, and control of purchased gas, under the chairmanship of J. A. Perry. The following paragraphs undertake to interpret concisely some of the outstanding facts presented at this symposium and in other parts of the conference program.

ENRICHMENT of manufactured gas with natural gas as a substitute for carburetting oil is practiced at York, Pa., with a blue gas as a base. The advantages anticipated, and realized, from replacement of gas oil with natural gas, even at equal cost, were: "The elimination of naphthalene and gum troubles with resulting improvement in service to the consumer; the improved stability of quality of gas with variable pressure conditions; the postponement of capital expenditures for generating equipment due to purchase of some 30 per cent of the gas requirements; the greater ease of purification due to reduction in hydrogen sulphide content; the absence of the variation of quality and price of gas oil, and, in a broader sense, the desire to cooperate with other parties engaged in the gas business."

Experience at York with automatic Smoot control on mixing indicates a very constant heating value on the city supply. Continuity of service is insured by having a 750-M holder for the storage of natural gas to insure supply in the event of temporary interruption on the transmission main. If long interruption is anticipated, restoration of normal carburetted water gas can be accomplished before the natural-gas supply in the works storage is exhausted.

At Binghamton, N. Y., similar enrichment has been practiced to some extent, but the re-forming of some of the natural gas has been found more desirable, in order that the natural gas used may make up a larger percentage of the total city mixture. Experience here and elsewhere apparently indicates that if the natural gas of more sluggish flame characteristic is substituted for carburetting oil to the extent of not more than 20 or 25 per cent of the mixture, there is no difficulty with appliance performance. But if, as was desired at Binghamton, the natural gas makes up as much as 40 per cent of the city mixture, then part of this supply must be re-formed in order to maintain the burner characteristic of the mixture more nearly like that of carburetted water gas. Or as an alternative, all appliances can, of course, be readjusted for the blue gas-natural gas mixture containing higher percentages of the latter. The experience at Binghamton indicates that "industrial appliances were affected more than domestic appliances, due to the finer



Baltimore Plant for Supplying Mixture of Coke-Oven, Oil, and Water Gas

adjustment of these appliances, but even here no real trouble was encountered."

Chicago is shortly to undertake the largest mixing operation ever practiced, using natural gas from the Panhandle of Texas for enrichment of coke-oven gas now received from five different plants. The mixture will be made up of the natural supply of 1,050 B.t.u. and 0.6 sp.gr. with coke-oven gas averaging 550 B.t.u. and 0.4 sp.gr. in such proportions that the city supply will be 800 B.t.u. The surplus of gas above the city distribution requirements will be taken by certain dump-load customers, principally the steam-electric station of the local public-utility power concern. Anticipating the change from the present gas supply to a much richer and heavier gas, a complete readjustment of gas-burning appliances throughout the entire city is being arranged.

THREE-CONSTITUENT mixtures also are being made in a number of localities. At South Bend, Ind., the locally generated supply was formerly carburetted water gas of 570 B.t.u. and is now a 255 B.t.u. blue gas made in the same machines. This is enriched to give a city supply of the same heating value and practically the same burner characteristics as formerly by adding a mixture of 1,000-B.t.u. gas supplied to South Bend by a pipe line from East Chicago. This 1,000-B.t.u. enricher gas is a mixture of coke-oven gas from the steel plants and petroleum byproduct gas from the oil refineries. The resulting performance of the gas in South Bend has indicated that such a mixture is very satisfactory, both for household and for industrial burners.

At Baltimore a much larger scale mixing operation, with considerably more complicated set-up is being successfully carried out. The accompanying diagram shows the layout required. The mixture is made from coke-oven gas received by pipe line from the Sparrows Point steel works, refinery oil gas of high heating value and very high sulphur content received from a nearby petroleum refinery, and a gas generated in the water-gas house of the works itself. The mixture, which averages 45 per cent coke-oven, 6 per cent refinery, and 49 per cent water gas, varies widely according to the total volume required for the city, the availability of coke-oven gas, and the volume and quality of the refinery gas received. The range is from 25 to 70 per cent coke-oven gas, from 4 to 6 per cent oil gas, and from 25 to 70 per cent water gas; and yet the city mixture is so maintained that its heating value, specific gravity, and burner performance do not change significantly from the standpoint of the customer.

Since very sudden and wide fluctuations in both volume and heating value of either coke-oven or oil gas may occur, automatic continuous recording devices are under almost uninterrupted observation by the works control staff. As soon as any change is noted in the purchased supplies, a compensating change is made in the water gas. Occasionally the changes are so abrupt that the mixed gas exceeds the limits permissible, in which case it is bottled up in one of the works storage holders and subsequently fed into the city system with a compensating supply from another source.

Another interesting feature of the Baltimore operation is the acceptance at the gas works of refinery gas containing from 3,000 to 5,000 grains of total sulphur per 100 cu.ft. Purification of this supply has been satisfactorily and economically worked out by the superintendent of gas manufacture, John H. Wolfe. A report of the details of that operation will be presented in a later issue of *Chem. & Met.* when the work has progressed to a point permitting a full technical description.

RE-FORMING of either natural gas or petroleum refinery gas is sometimes essential. At Toledo, where the mixture sent out to the city includes coke-oven gas, water gas made in the company's own plant, and purchased natural gas, the natural-gas supply is re-formed in one of the water-gas machines by admission of this gas at the top of the superheater and the base of the generator. Natural gas initially having 1,020-1,060 B.t.u. per cu.ft. is partially cracked, forming a mixture of 560-585 B.t.u. and containing a sufficient percentage of hydrogen and unsaturated hydrocarbons that it can be successfully mixed with the other gases in widely varying proportions without producing objectionable variation in appliance performance of the mixture.

Re-forming of refinery gas has been practiced at Chester, Pa., for nearly two years. The re-forming of 1,500 B.t.u. oil gas of a gravity approximately 1.0 is accomplished by the U.G.I. process in a water-gas machine so that the resulting re-formed mixture is made up of blue gas and cracked refinery oil gas together with producer gas made during the blow-run part of the cycle. By varying the cycle the product can be varied from 360 to 450 B.t.u. and from 0.5 to nearly 1.0 sp.gr. This gas is enriched with more uncracked refinery gas of 1,500 B.t.u. heating value to furnish a city supply of 520 B.t.u. and a specific gravity averaging 0.58.

Operating results obtained at the Chester plant indicate that a 9-ft. internal diameter mechanical-generator carburetted water-gas machine can re-form enough gas to be equivalent to 7,000,000 cu.ft. of 530 B.t.u. city gas per set-day. Thus the send-out per unit of capital investment is comparatively high. The experience at this plant also has shown the feasible relationships between fuel use, specific gravity, quantity of refinery gas, and the characteristics of the finished gas made.

Mixture-control devices for maintenance of uniform send-out have, of course, been an essential part of the utilization of mixed supplies. R. P. Oliveros, of Semet-Solvay Engineering Corp., in a report to the conference, discussed both manual control and three types of automatic-control equipment, the Smoot mixer, the Cutler-Hammer Calorimixer, and the Bailey ratio-control equipment. In his report he points out how all three of these systems have been successfully applied to practical works operation. He refers also to other processes now under development for which later reports on works trials are anticipated by the sub-committee of A.G.A. which deals with these facilities.

THIS CHEMICAL REVOLUTION

A Chimera of Depression—

Our Only Way Out

By WILLIAM J. HALE

Director of Organic Chemical Research
Dow Chemical Co.

EDITOR'S NOTE: *In his address before the annual meeting of the Manufacturing Chemists' Association at Absecon, N. J., June 4, Dr. Hale presented this unique view of the future industrial development of the United States. Chemistry may or may not be the answer to all our problems, but here it finds a fascinating advocate. Extracts from his address follow.*

IN THE PAST HUNDRED YEARS, man has accomplished more for the development and fulfillment of the larger life than his forebears accomplished in the milleniums that have gone before. But the inborn habits of man have not so readily yielded to each new adjustment. Only through a general education of the masses has it become possible to create an adaptability and ready response to the requirements of new environment. In America in particular our educational standards are steadily rising, thus making of this country the greatest potential market in the world.

We have been wont to look upon the farmer as the backbone of civilization. His life of independence endeared him in the eyes of his countrymen and bedecked him with a halo of liberty. Yet today his independence seems well-nigh dissipated, and his crown has lost its radiance.

What has come upon us that has wrought so great a change in the field of agriculture? In the early days of our modern industrial era, ushered in by the Bessemer furnace of 1856, we witnessed nothing of sinister portent to the farmer. As recently as 1900, no dark clouds had threatened. By 1910, however, there appeared unmistakable signs of a coming revolution. But with the advent of the World War, this imminent danger vanished. The exigencies of War spurred every single activity to its utmost. In fact, through this speeding up of scientific technology, we note the beginnings of the downfall of agriculture. The felling hand was none other than organic chemistry.

In the early days of this century, we note the introduction of artificial silk on a commercial scale in England. By the close of the first decade, its manufacture was in operation in this country. During the World War the great demand for cellulose acetate as dope for airplane wings hastened research looking toward cheaper cellulose, and by the close of the World War we were in excellent position to manufacture alpha cellulose from wood.

Scientific development by 1918-1919 presaged a tremendous advance in the years to follow. The readjustment that followed the World War, however, retarded the immediate advance, and for a year or two a period of depression fell upon all countries. During this depression, scientific research naturally did not remain dormant, and after a few years we note again tremendous forward strides in the field of technology.

> **"We read today with amazement lengthy articles discussing the cause of this so-called depression. Some ascribe it to high tariffs, others to international debts, others to an aftermath of the World War. As a matter of fact, it has little or no relation to any of these chimeras. In truth, it is no depression at all. It is merely the return of a chemical world to normalcy, or that state where chemical worth and price values are consonant. If we can maintain this state, we shall be able to build to greater heights than the world has ever dreamed in its rosiest dreams. The downfall of fictitious prices naturally threw inefficient and uncalled-for manufacturing out of kilter. This precipitated much unemployment, a menace to normal production and consuming power, and typifies the present as life at low gear. Today we are experiencing a readjustment of our activities to a sane and scientific basis. We must make ready with new projects and new articles of commerce. The mistakes of yesterday need not restrain us. Every industry should become lavish with money for research; upon this more than all else rests our security for the future."**

Had the industrialists of this country taken cognizance of these scientific accomplishments and correlated them with that principle which demands an ever lowering in prices of basic commodities in an advancing civilization, we never would have witnessed that orgy of high prices which reached its climax in 1929.

It required no one of more than mediocre ability to observe that the scientific trend of the post-war period was leading directly to a substitution of the ultimate components of agricultural products by chemically prepared material. In particular have we reference to the great world of carbohydrate chemistry. This, of course, is the field par excellence of agriculture and the chemical revolution to which we refer centers upon the replacement of the well-established agricultural activities by new, diverse, and cheaper chemical manufacturing processes.

IN THIS organic chemical revolution lies the deep-seated cause of our present-day conditions. Those industrialists and politicians who cry aloud for higher prices on agricultural staples, in order that the money paid to the farmers will find outlet in greater purchasing power for industrial products, are only crying for their own destruction. Chemistry decrees that these organic chemical mixtures—staples, if you wish—never again can sell for more than the sum of the chemical values of their several components, and simply because these components are obtainable elsewhere with less expenditure of labor. Thus, cotton of 99 per cent alpha cellulose content is of little more value than the alpha cellulose of 98 per cent purity, obtainable now from wood at a price

of 6 to 7 cents per pound. Cotton, therefore, must compete with this alpha cellulose, and unless it can be sold for approximately 10 cents per pound or less, it will sooner or later pass entirely out of domestic consumption. Corn, wheat, and other staples must follow in line. Corn at 40 cents per bushel, wheat at 60 cents per bushel, carry a value about the equivalent of the sum of the values of the chemical components contained in these grains, and never again should sell at higher prices.

It is reported that we are in a period of depression, but how can we consider prices depressed when they approach the actual values of the products concerned. Thus, crude oil at the wells is not worth over 50 cents a barrel, nor is coal at the mines worth more than two dollars a ton, and yet there are those who would have us believe that petroleum must be conserved, that it is a great asset to the country, and that its passing might mean our undoing. To all this, the chemist's reply is, "Tommyrot!" We don't need this oil; use it as best we can at as low a price as possible. When it is gone, we shall use up the coal, also at as low a price as possible. When the coal is gone, we shall manufacture hydrocarbons at lowest prices, and our children will relate stories of how their fathers wasted their time digging holes in the ground to get out a lot of dirty fossil remains at a tremendous cost of time and labor. There is nothing so childish as this cry of conservation, when the chemist already knows how to provide the requirements in heat, power, and light for the human race without any coal or oil in the picture.

Many claim that corn, wheat, cotton, and other staples are now selling below the cost of their production. Undoubtedly, this is correct for certain sections of the country, but for other sections it is most decidedly not. Wherever a high cost of production prevails, the agriculturist must cease this particular pursuit. What we want are low-priced basic commodities, and these we will have.

CHEMICAL INDUSTRY is the great outlet for agricultural staples. Farmers should enter into contract with near-by chemical units for the delivery to these units of the products needed. Under a contract based upon acreage, no matter what number of bushels the farmer can raise per acre, the industrial units must take all that the acreage under contract produces. This procedure at once promotes efficiency, and at the same time holds prices at proper levels. What matters it if up to this time no one has been willing to contract with the farmer? Certainly no rational individual or sound organization could be expected to pay the exorbitant prices that heretofore have obtained for the crudest kind of chemical mixtures, prices out of all proportion to the combined selling prices of the several components contained in these mixtures. With agricultural commodities now approaching their chemical values, it is reasonable to anticipate a greater and greater adaptation of these commodities to chemical processing.

It cannot be expected that within the next year or two all of the corn, wheat, cotton, and other staples can possibly find an outlet in the chemical industry. This means that the farmers, in the meantime, must undertake the cultivation of other agricultural products that may more quickly find chemical utilization. In this direction our industrial organizations must bend every effort toward the furtherance of chemical manufacture, making use of the raw materials of the land. Those who fear discontinuance of natural products as raw materials for chemical enterprise should bear in mind that chemistry cannot more cheaply synthesize carbohydrates and proteins than does Nature. It is our duty, therefore, to make our farm lands a more and more dependable source for the raw materials of industry. In this lies the greatest possible future both for agriculture and industry.

Herein—in the enlargement of our activities—shall we find the solution of our present-day problem—the one and only direct means of pronouncing a doom upon all unemployment. Many researches already completed and many in process of completion are begging for sponsorhood. Primarily the problems touching raw products from the land constitute the exact type upon which money should now be spent. Of these, only five need be mentioned: (1) The Jerusalem artichoke as a better source of a sweeter sugar; (2) the peanut for its oil content—hydrogenated, if you wish, to make the best lard substitute ever brought on the market; (3) the sweet potato for starch as well as other carbohydrates; (4) the soy bean affords an excellent source of protein and nutritious flour, while the oil gains steadily in industrial use, and (5) the poplar tree to yield 3,000 to 4,000 lb. of pulpwood per acre per year.

Not alone shall we cultivate our lands for material to serve as food, raiment and shelter. There is a larger use in store. This is the application of sunlight on islands contiguous to our shores. Through chemical and physical developments in southern waters, we shall obtain tremendous quantities of power. If England and France would like to sell us something, why not sell us what we really need, such, for example, as their island possessions in the West Indies. These islands will some day far surpass in value the sum of the total indebtedness of England and France to us. Amicably, now, their debts could be wiped out by one simple trade.

SO MUCH that we do today is wrong—wholly inconsistent with the state of present-day knowledge—that it becomes difficult to find anything that is right. All we are, all we do, all we ever hope to be, is merely a matter of chemistry, and yet chemical considerations of our daily problems are seldom sought. Our daily life is just one grand obsolescence. We still make use of hides of animals for shoes; we still saw timber to extract flat boards; we still plow fields for aeration and killing of weeds; we still use gasoline and air for internal-combustion engines; we still haul coal by railway; we still use coke in metallurgy; and the noise in our cement-covered streets, littered with street cars on steel rails, outstrips Bedlam. What travesties on research!

There is an inertia about the average business man that renders him resistant to change. Processes long out of date are discarded with no gusto. The abdication of flimsy excuse as a reigning power or basis for business organizations is everywhere rampant. The day of reckoning is at hand. Upon chemical factors alone lie the basic hopes for success of all business. Those who will not grasp the new shall certainly be lost. Through mutually interchangeable privilege upon a royalty basis, we must hasten to contract with those who can supply us with any new improvement affecting our each and every pursuit. Thus the many research projects crying for commercialization will find ready adoption—and to the end that greater and greater chemical adaptation of Nature's gifts to man will contribute increasingly to the larger and fuller life.

READERS' VIEWS AND COMMENTS

An Open Forum

The editors invite discussion of articles and editorials or other topics of interest

The Case for the Film Evaporator

To the Editor of Chem. & Met.:

Sir:—In the April number of your paper appeared an article by W. L. Badger on evaporator design. While we always read Mr. Badger's offerings with great interest and have great faith in what he says, he has permitted several errors to creep into the present paper.

He states: "it is now generally recognized that there is no real difference between the so-called 'submerged-tube' evaporators and the so-called 'film' evaporators. Any vertical-tube evaporator may be operated with high liquor levels, so that it may be called a submerged-tube machine, or it may be operated with low liquor levels, in which case its performance passes over more or less completely to the so-called film type." But what are known on the market as submerged-tube types cannot be operated as "film" evaporators whatever the liquor levels. With low levels they tend to become "rapid-circulation" types, but never "film" types. Likewise, a properly designed film evaporator can never become a "submerged-tube" type at any so-called liquor level, which we must understand in this case to mean "feed head."

Again we read: "One of the difficulties with the Kestner evaporator was the fact that the liquid passed through the evaporator only once and therefore the feed had to be controlled very carefully or the tubes would go dry. The operator usually preferred to err on the other side, and tended to put the liquid through with too little concentration. The obvious cure for this situation was to supply a return tube from the vapor head back to the feed chamber of the same effect."

The Kestner evaporator was expressly designed to pass the liquid through only once, doing the required concentration in the one pass, to reduce the time the liquid was in the evaporator to the minimum possible. It is this that makes the quality of those materials which are sensitive to heat, superior if the concentration is done in a Kestner. It was designed to pass the liquid through the tubes at the highest speed possible without mechanical pumping (and it does), and thereby reduces the scaling to the minimum.

After 25 years on the market the Kestner is the only true film evaporator. Its rate of heat transfer is greater because the velocity in the tubes is double that of its competitors, as is the velocity of the steam or vapor on the outside of its tubes. The time of contact of the liquid being concentrated with the heating surface is one-tenth to one one-hundredth that in the so-called high velocity types—a tremendous advantage with delicate liquids. The introduction of that little return tube—"the obvious cure," as Mr. Badger puts it—made the high-speed evaporators more foolproof at the expense of efficiency and quality of product. Not only is the method of feeding the Kestner extremely simple but the concentrated liquid is discharged hour after hour, day after day, at the desired density and the tubes never go dry.

Mr. Badger states "the Kestner evaporator as such has never been successful in the United States." Due to certain conditions of organization, the Kestner Evaporator Co. here was not a success. But the Kestner *evaporator* was and is a success here as elsewhere.

RALPH MELLOR.

Consulting Engineer,
Ardmore, Pa.

Prof. Badger Enlarges On His Conclusions

To the Editor of Chem. & Met.:

Sir:—In reply to Mr. Mellor's first criticism that there is a real distinction between the so-called "film type evaporator" and any vertical-tube evaporator operated with low liquor levels, it may be said that the distinction Mr. Mellor tries to draw is a distinction without a difference. Anyone is free to postulate any imaginary conditions he pleases as occurring inside an evaporator tube. The actual facts of the matter are that as tube lengths are gradually increased and as liquor levels in the tube are gradually lowered, there is no indication of anything but a gradual and regular increase in the heat transfer coefficients. At no time does it appear that the operation passes decidedly from one type to another type.

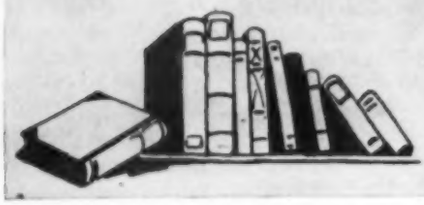
With regard to Mr. Mellor's contention that the Kestner evaporator has been successful in the United States, the writer does not deny that several Kestner evaporators have been in operation for a number of years and have apparently given satisfaction. On the other hand, it is certainly true that the number of Kestner evaporators sold in the United States has been entirely negligible in comparison with the number of all types sold. Whether this is a fault of the Kestner evaporator or of the company which marketed it in the United States the writer does not presume to state, but at least it may be said that the Kestner evaporator has been a negligible factor in the evaporator field in this country.

The writer can state, positively, that irrespective of the claims made by the makers of the Kestner evaporator and by the makers of the other long-tube, high-speed evaporators (whether natural or forced circulation), actual data, either from laboratory tests or plant operation generally available, have never shown any higher coefficients or better performance for the Kestner than for the other long-tube, high-speed types.

W. L. BADGER.

Professor of Chemical Engineering,
University of Michigan,
Ann Arbor, Mich.

CHEMICAL ENGINEER'S BOOKSHELF



American Chemistry in 1930

ANNUAL SURVEY OF AMERICAN CHEMISTRY. Vol. V, 1930. Edited by *Clarence J. West.* Published for the National Research Council by the Chemical Catalog Co., Inc., New York City, 1931. 630 pages. Price, $5.

Reviewed by D. B. KEYES

IT IS always with pleasure and interest that we greet the annual issue of the Survey of American Chemistry. This fifth volume contains some new chapter headings; for example, Subatomic Phenomena, by Harold C. Urey; Physical Methods in Analytical Chemistry, by E. G. Zies; The Rare Earths, by B. S. Hopkins; Cement and Concrete, by John Tucker, Jr.; Chemistry of the Silicates, by George W. Morey; Chemical Economics, by Lawrence W. Bass; and the combining of two chapters on Paints, Varnishes, and Lacquers, by V. C. Bidlack. New authors also have appeared besides those mentioned above. There are at least ten new names. This attempt to obtain new viewpoints is proving to be very much worth while and lends a new interest to the volume. Dr. West should be complimented on his continued good work and especially for his introduction of a chapter on economics.

As the years go by, of course, the material covered is greater in scope, and though we have no particular criticisms on the way the survey has been made in the past, it might be well to add other sections such as electrometallurgy, electro-plating, and electro-organic reactions. It also might be worth while to cover the patent literature more thoroughly, for example, on such fundamental subjects as catalysis and synthetic yarns.

From the industrial man's standpoint, the ideal Annual Survey of American Chemistry should include a chapter on every large chemical industry, containing at least one man's ideas of the most promising fields for research and development from an economic standpoint. Our economists know so little of the technical side of the chemical industry; our chemical engineers have so little time to develop their vision of the future; and our scientists are so little interested in the future of a particular industry that very little is said or written about the direction research should take in our industries. It is not necessary for the writer of the article to be correct. It is only a question that he should have an idea based on scientific, engineering, and economic facts. Even though the reader disagreed with him, the article still would be stimulating.

In brief, the Annual Survey of American Chemistry in the form of its fifth volume has appreciated the value of economics and we hope it will continue to enlarge its scope to include a scientific, engineering, and economic prediction as to the best possible lines of research and development for chemical processes in the industries of the United States.

The Graphite Industry

DER GRAPHIT. By *Oscar Kausch.* Verlag Wilhelm Knapp, Halle (Saale), Germany, 1930. 247 pages. Price, 26 M.

Reviewed by C. L. MANTELL

THIS volume is loaded with references to the technical and patent office literature. The author is a member of the German Patent Office staff. In the first section of the book, natural graphite, its occurrence, properties, ore dressing, winning, and refining are discussed. This is followed by a section on the preparation of artificial graphite. Individual chapters treat of graphite from various angles for use as electrical conductors, electrodes, in lead pencils, crucibles, lubricants, coloring matters, absorbents in medicine, as well as for other diverse uses. The volume is completed by a chapter containing graphite statistics, and tables of recent literature and patent references. The author does not attempt to be critical of the statements made by various patentees and authors, but compiles all of them in a comprehensive manner.

Sulphuric-Acid Compendium

LUNGES HANDBUCH DER SCHWEFELSÄUREFABRIKATION. Edited by *Bruno Waeser.* F. Vieweg & Sohn A.G., Braunschweig, Germany, 1930. Part I. Production of Sulphur Dioxide, 848 pages; Part 2, The Lead Chamber Process, 577 pages; Part 3, The Contact Process. 610 pages. Price, 204 M.

Reviewed by A. E. MARSHALL

WAESER, with the fourth (1916) German edition of Lunge's Sulphuric Acid as his framework, has successfully abbreviated or reduced to abstracts much of the Lunge material now only of special interest, has preserved the classic pages, and fitted into their proper places the last 16 years' developments in both chamber and contact sulphuric-acid processes. The result of Dr. Waeser's labors is an up-to-date Lunge, superior to Wyld's and Miles' recastings in English of Lunge's fourth edition, even after making proper allowance for the many useful disclosures, by publication and otherwise, in the six years since their volumes were brought out.

Waeser's volumes and chapters follow the Lunge pattern: historical development, raw materials, commercial methods, furnace and equipment for producing sulphur dioxide, the lead chamber and various tower systems for acid manufacture, production and recovery of oxides of nitrogen, acid concentration, the contact or catalytic processes, and finally statistics of the industry. The editor (one feels after a study of the 2,036 pages that

perhaps editor is too modest and "author" a more deserved title) has certainly kept his publication and patent references up to date, and so has enabled one of his readers to put into storage files a large portion of an assortment of clippings, bulletins, and the like.

The American technologist probably will find the third part, "The Contact Process," the most interesting, as it discusses in considerable detail the theories of catalysts and sets down in continuous form the development and the operation of all the modern contact masses. The contact-process patent references indicate a careful study of the patent records of practically all patent publishing countries, and by themselves justify the inclusion of Waeser on the library shelves of the acid makers.

Remembering Lunge and his pioneer work in establishing a literature background for the heavy chemical industry, as one turns over the pages of Waeser, a passage from Shakespeare keeps reciting itself:

> He was the mark and glass, copy and book,
> That fashioned others

and with a bow to Waeser one bows to the shade of Lunge.

Relations With Russia

SOVIET FOREIGN TRADE: MENACE OR PROMISE? By *J. M. Budish* and *Samuel S. Shipman*. Horace Liveright, Inc., New York City, 1931. 276 pages. Price, $2.50.

WHY RECOGNIZE RUSSIA? By *Louis Fisher*. Jonathan Cape & Harrison Smith, New York City, 1931. 298 pages. Price, $2.

Reviewed by RICHARD KOCH

RUSSIA, or more properly the U.S.S.R., has somewhat monotonously confounded its prophets of calamity for almost 14 years already, without ever offering any real clue for predictions. Meanwhile its destiny has come to affect not only commerce and diplomacy but also the scientific and engineering professions—and to a great extent the publishing business too, one is tempted to add. For the two studies in question here are merely selections from a now very populous group, most of it devoted to deprecation of the Soviet.

Both books may be counted on the protagonistic side, the first by reason of its origin at the Amtorg and the second because of its unusual absence of phobia. Fortunately for their respective theses, the first amounts to a set of commercial statistics and the second to a critical review of the Soviet's outside negotiations and reception. But both deal with a vast single problem that will be increasingly vital to the world's wealthiest country as its technical and commercial contacts with the world's largest become more insistent.

The Budish-Shipman compilation, apart from its value as an information source, seems to plead on two bases. First, that the very theory of foreign commerce makes exports and imports necessary concomitants, in which case Russian trade is demonstrably a "promise." And second, that the United States are far and away on the long end of the bargain and shouldn't let it go entirely to Europe. Without an attempt at penetrating the maze of interdependent considerations, it must still be reflected that this widely voiced inducement is, after all, a temporary appeal to greed, which were best abandoned in favor of the international economic argument. What the business world wants to know, then, conceding the general desirability of a "healthy" Russia, is the stability of the present scheme of things and its approximate financial and personal hazards.

One of the principal factors in stability is the personal lot and satisfaction of the Soviet population, which neither of these books (nor any other) has reliably interpreted. In the necessary absence of this information, Mr. Fisher, author of several larger studies on the question, does the next best thing by illuminating Moscow's official dealings outside, mainly by quotation from American and European documents. He finds that the matter of Soviet "irresponsibility" in Czarist debts is largely erroneous, the basis for counterclaims rather serious, and the theory of repudiation at least indorsed by practice here and abroad. A main point that becomes clear is that non-recognition is effecting nothing whatsoever (except "mere puttering about with a big and grave problem"), while the possible gain by recognition in honorable commercial and diplomatic progress would be very high. The Soviets number 160,000,000 people, who can't merely be ignored out of existence.

A similar critical work on Russia's technical life might be even more beneficial than Fisher's book, but for anyone genuinely concerned about her international aspects, a more interesting one could scarcely be found. If self-criticism is salutary, then the inflammatory official outbursts liberally quoted here should certainly induce a sobering influence on their authors, in all camps, and a more thoughtful attitude on the productive constituencies really affected by Russia's destiny.

Other Recent Arrivals

KEYSTONE COAL BUYERS' CATALOG AND MINE DIRECTORY, 1931. McGraw-Hill Catalog & Directory Co., Inc., New York City, 1931. 854 pages. Price, $15.—Completely revised since the prior edition, the new one carries additional special information on officials of coal companies. The usual arrangement by states, with maps and precise descriptions of properties, is maintained. The chemical industries, which now consume over 27 per cent of the national coal production, should be especially interested in its newest form.

MATERIALS HANDBOOK. By *George S. Brady*. Second Edition. McGraw-Hill Book Co., New York City, 1931. 588 pages. Price, $5.—Although 150 pages longer in text, the increased bulk and additional $1 in price of this new edition contribute very little to impairing its chief excellence, convenience. On the other hand, the description of materials has been expanded throughout, to the inclusion of materials grown significant in the past two years. All in all, a most satisfactory reference book wherever scientific exhaustiveness is not a prime consideration.

"MUNROE AND JAMIESON" ELECTRICAL RULES AND TABLES: A Pocket-Book. 23d Edition. By *W. R. Cooper* and *Rollo Appleyard*. J. B. Lippincott Co., Philadelphia, Pa., 1931. 765 pages. Price, $4.—A revised reference book of electrical practice, including electrochemistry, brought into reduced dimensions and price. Would be serviceable in almost any plant.

Editor's Note: Because of its quick adoption in a number of schools and by many members of the profession, Badger and McCabe's "Elements of Chemical Engineering," reviewed by *Chem. & Met.* in February, has been supplied with an erratum-slip by its publishers, the McGraw-Hill Book Co. Copies may be obtained from the company's office at 370 Seventh Ave., New York City, on application.

SELECTIONS FROM RECENT LITERATURE

EVAPORATION AND VISCOSITY. J. Weichherz. *Chemiker-Zeitung*, May 6; pp. 341-2. As an example of the effect of viscosity of liquids on evaporator performance, evaporators used in making malt extract show a critical point, beyond which the evaporating effect rapidly decreases. This point is influenced by the design and efficiency of the apparatus, and by changes in the boiling point and specific gravity of the extract; but the viscosity of the liquid is a major factor in deciding the critical point. Curves, showing the effect of solid-matter content on viscosity in malt extracts of average composition, rise steeply from about 15 per cent solids in the cold extract, and from about 30 per cent solids in the hot extract. These curves are shown for 10, 20, 30, 40, 45, 50, 55, 60, 70, 80, and 90 deg. C. It was also observed that the viscosity increase is about 43 times as rapid between 40 and 50 per cent solids as between 1 and 5 per cent. The effect of viscosity on evaporator performance is mainly a result of decreasing mobility and slower heat transfer in the liquid as it becomes more viscous. From the practical standpoint, the amount of solids in the extract, at which the viscosity begins to decrease the evaporating effect to an undesirable degree, depends on the operating conditions and on the design of the evaporator. In an ordinary evaporator, heated with fresh steam at a medium pressure, operating at about 45-50 deg. C., the critical point is reached somewhere between 40 and 50 per cent solids content in the extract being evaporated.

HEAT EXCHANGER CONSTRUCTION. H. Binder. *Zeitschrift des Vereins Deutscher Ingenieure*, April 11; pp. 465-6. For purposes of heat exchange in chemical processes, it is important to have apparatus made of heat-resisting and acid-resisting material; yet the cost must not be excessive. Tubing has many advantages, but the cost of constructing a heat exchanger from tubing is too great if all connections are made to withstand the same severe conditions as the metal. A new type of construction has now been developed, in which sheet metal, suitably welded, can be used to a large extent. The new system is adapted from a design for steam radiators for house heating, and is useful for condenser units in distillation, for heating or cooling gases, and like purposes. In stamping the shapes for these welded heat exchangers, it is necessary to take great care not to cause any change in the physical structure of the metal, such as recrystallization, which would lessen the resistance to acids. As examples of the construction of heat exchangers of the radiator type, descriptions and drawings are given of a condenser system and an acid cooler. In the condenser system, three of the radiator type units are provided, from which the condensate is collected in a pipe and passed to a cooler which also has three radiator units. The cooler comprises a water bath, operated on the counter-current principle. In this system the units are in parallel; by connecting units in series, the effect can be varied, so that heat exchangers may be adapted for heating or cooling either liquids or gases. Nickel, Monel metal, nearly all chrome-nickel steels, and certain heat-resisting steels are suitable metals for making these heat exchangers.

PRESSURE CARBONATION OF SUGAR JUICE. Gaston Duret. *Bulletin de l'Association des Chimistes de Sucrerie*, April; pp. 183-8. The first industrial application of pressure carbonation of beet sugar juice was made in 1929, and was carried on side by side with the older batch system of carbonation. Pressure carbonation, as now practiced on the basis of this development, is continuous and has the further advantages given by the increased reactivity of carbon dioxide under pressure. Thus, the gas is utilized to the extent of 83-85 per cent; and in a refinery using three gas generators, it was found that two could be made to suffice, that 25 per cent of the filter presses could be dispensed with, and that a corresponding reduction could be made in the number of workmen. The continuous pressure carbonation apparatus has a cylindrical autoclave, to which are fed simultaneously the limed juice and the carbon dioxide. The partially carbonated juice escapes through an overflow pipe to a second autoclave; the excess carbon dioxide passes from the top of the first to the bottom of the second autoclave, and bubbles through the juice, which is at least 14½ ft. deep. The completely carbonated juice is then passed to the carbonated juice vat. The first autoclave is fitted with a safety valve and a pressure gage. The optimum pressure is about 1 kg.; hence the apparatus must be able to withstand pressures at least up to 1.5 kg. A drawing of the apparatus is shown. The process is considered to be applicable also to sulphitation of sugar juices.

Recent Government Publications

Documents are available at prices indicated from Superintendent of Documents, Government Printing Office, Washington, D. C. Send cash or money order; stamps and personal checks not accepted. When no price is indicated pamphlet is free and should be ordered from bureau responsible for its issue.

German Chemical Developments in 1930, by Willam T. Daugherty. Bureau of Foreign and Domestic Commerce Trade Information Bulletin 753; 10 cents.

Tariff Commission Reports. Five documents in the Second Series of the Commission's reports to the President, as follows: No. 3, Synthetic Phenolic Resin, 10 cents; No. 4, Cost of Crude Petroleum, 15 cents; No. 6, Wood Flour, 5 cents; No. 7, Pigskin Leather, 5 cents; Nos. 10 and 11, Wool Floor Coverings and Ultramarine Blue, 5 cents.

The German Lithopone Industry and Trade, by W. L. Lowrie. Bureau of Foreign and Domestic Commerce Chemical Division Special Circular 339; mimeographed.

Tartaric Acid Industry in Spain, by Katherine Elliott. Bureau of Foreign and Domestic Commerce Chemical Division Special Circular 341; mimeographed.

Essential Oil Trade. A series of documents in mimeographed form from the Chemical Division, Bureau of Foreign and Domestic Commerce, dealing with production and foreign trade throughout the world in essential oils. The following parts are now available: No. 1, France; No. 2, Brazil; No. 3, Yugoslavia; No. 4, French Morocco; No. 5, Australia; No. 6, Guatemala; No. 7, Germany; No. 8, Persia.

Leather Industry and Trade of Japan, by J. Schnitzer. Bureau of Foreign and Domestic Commerce Trade Information Bulletin 755; 10 cents.

Federal Specifications issued by the Federal Standard Stock Catalogue Board as follows: Integral waterproofing material (for use with Portland cement-mortar or concrete, calcined gypsum, acetone, petroleum ether, glycerin (Glycerol), dry-cleaning solvent; 5 cents each.

Alcohol Regulations. New editions of Bureau of Industrial Alcohol regulations as follows: Regulations 2, Relating to Permits for Manufacture and Traffic in Intoxicating Liquors for Non-beverage Purposes; 40 cents; Regulations 3, Relative to Production, Tax Payment, etc., of Industrial Alcohol and the Manufacture, Sale, and Use of Denatured Alcohol, 20 cents.

Mineral Production Statistics for 1929—Separate pamphlets from the Bureau of Mines on: Manganese and Manganiferous Ores, by Lewis A. Smith, 10 cents; Gold, Silver, Copper, and Lead, in South Dakota and Wyoming, by Chas. W. Henderson, 5 cents; Phosphate Rock, by Bertrand L. Johnson, 5 cents; and Tin, by Charles White Merrill, 5 cents.

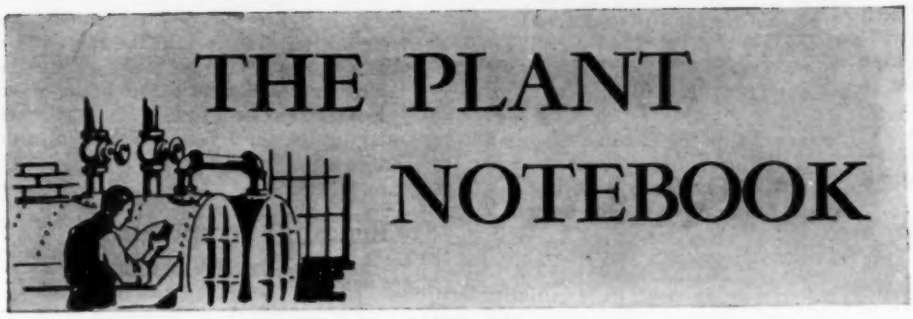
Mineral Production Statistics for 1930—Preliminary mimeographed statements from the Bureau of Mines on: Abrasive materials, aluminum salts, natural sodium compounds, magnesium, carbon black, magnesite, bauxite, potash, slab zinc and rolled zinc, fluorspar, iron, refined primary lead, asphalt, and salt, bromine, and calcium chloride.

Hafnium, by Paul M. Tyler. Bureau of Mines Information Circular 6457; mimeographed.

Reduction of Zinc Oxide by Methane or Natural Gas, by H. A. Doerner. Bureau of Mines Report of Investigations 3091; mimeographed.

Propulsive Strength and Rate of Pressure Development of Cardox Blasting Device, by N. A. Tolch and G. St. J. Perrott. Bureau of Mines Report of Investigations 3084; mimeographed.

U. S. Bureau of Mines Stream Pollution Investigation, by R. D. Leitch. Bureau of Mines Report of Investigations 3098; mimeographed.



Effect of Inert Gas in a Circulatory System

IN ANY recirculating system operating on gases, continuous introduction of an inert gas will result, through the functioning of the law of mass action, in the gradual depressing of the reaction equilibrium. If it is possible, however, to remove the inert gas by bleeding or purging at a rate equal to its rate of introduction, then the reaction equilibrium will settle down at a point corresponding to the continuously maintained concentration of the inert gas. Excessive bleeding will defeat the purpose of the reaction, while if the bleeding be insufficient, the maintained concentration of inert gas will be too high and a low yield will result. For every synthesis the economic bleeding rate must be calculated separately, basing the calculations on the values and other factors peculiar to the synthesis in question.

In what follows an attempt will be made to show mathematically the effect of argon in the ammonia synthesis system. The method is taken from a report written by C. S. Fazel, then with the Fixed Nitrogen Research Laboratory, and is now published for the first time with the permission of the Director of the laboratory. In the complete report, Dr. Fazel showed calculations in addition to those given here which developed the theoretical purging rate for a circulatory system producing synthetic ammonia. He also pointed out that sufficient information is now available from actual installations to permit a comparison of calculated and experimental results. The basis for calculation of purging rate which is developed below is also illustrative of the method of approach to the same calculation for other syntheses.

The Effect of Argon on the Equilibrium Concentration—The effect of argon is to alter the equilibrium concentration of ammonia in the system. The magnitude of this effect can be determined from the law of mass action:

$$K_P = \frac{P_{NH_3}}{P_{N_2}^{\frac{1}{2}} P_{H_2}^{3/2}}$$

The total pressure, P, is the sum of the partial pressures:

$$P = P_{NH_3} + P_{N_2} + P_{H_2} + P_A$$

Since hydrogen and nitrogen are introduced in a 3:1 ratio

$$3 P_{N_2} = P_{H_2}$$

Combining the three equations:

$$P_A + P_{NH_3} + 4\sqrt{\frac{P_{NH_3}}{3^{3/2} K_P}} - P = 0$$

Let $C = \frac{P_{NH_3}}{P}$ and $C_A = \frac{P_A}{P}$

Then

$$C_A + C + 4\sqrt{\frac{C}{3^{3/2} K_P P}} - 1 = 0$$

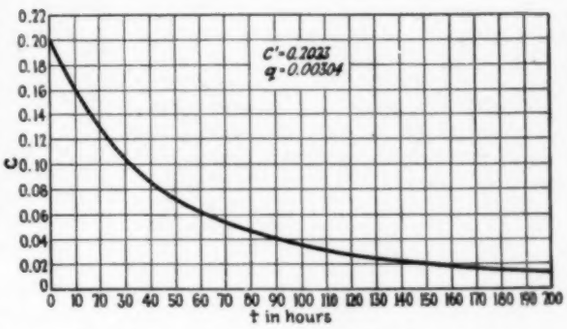


Fig. 3—Decrease in Conversion With Time as Argon Concentration Builds Up; Same Plant as Fig. 2

Let $\alpha = \frac{4}{\sqrt{3^{3/2} K_P P}}$

Then $$C_A = 1 - C - \alpha\sqrt{C} \qquad (1)$$

This is permissible, since under a given set of conditions α changes very little with pressure.

When no argon is present, $C_A = 0$ and $C = C'$ and $\alpha = \frac{1 - C'}{\sqrt{C'}}$

or $$C_A = 1 - C - \frac{1 - C'}{\sqrt{C'}}\sqrt{C} \qquad (2)$$

This gives the relation between the equilibrium concentration of ammonia and the concentration of argon. Fig. 1 shows the relation graphically for several values of C'.

In a given plant with 1 per cent argon the temperature and pressure are such that the percentage conversion per pass is 20 per cent. Then

Fig. 1—Showing Effect on Conversion Percentage of Various Argon Concentrations for Syntheses of Several Conversion Characteristics

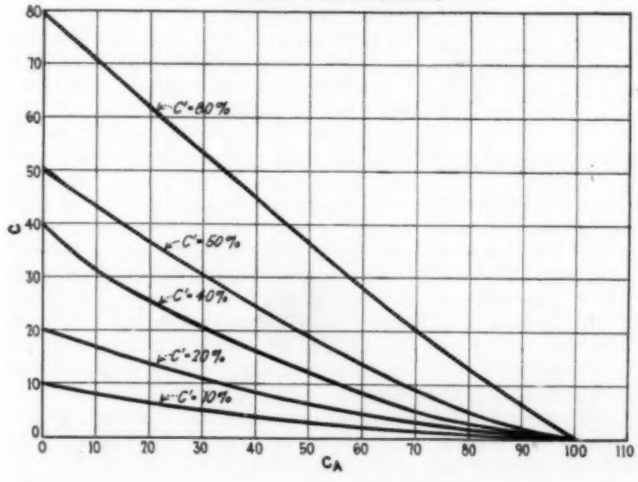
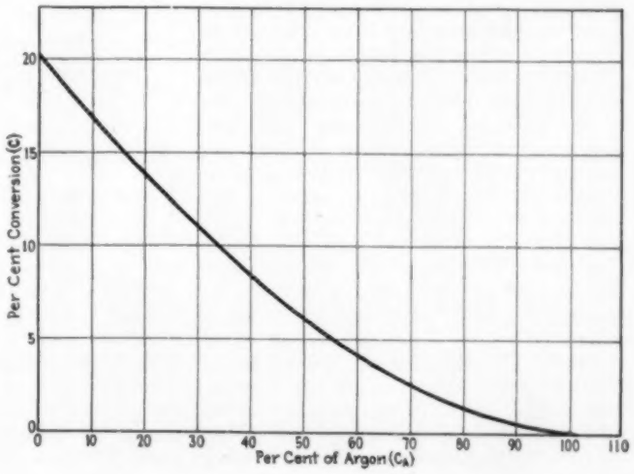


Fig. 2—Effect of Argon Percentage on a Plant With Conversion of 20.23 Per Cent at a Theoretical Zero Argon Concentration



$\frac{1-C'}{\sqrt{C'}} = 1.769$ and $C' = 20.23$ per cent

In Fig. 2 the effect of any percentage of argon on the output of the plant is shown. Thus if the plant is designed to turn out 3.3 tons per day on gas containing 0.304 per cent argon the following table shows the expected output of ammonia:

C_A	Output, Tons per Day
1	3.3
5	3.07
10	2.86
20	2.31
40	1.40
80	0.207

Decrease of Ammonia Conversion With Time—If the rate at which gas flows into the circulatory system is X and the percentage of argon in the intake gas is q, then the volume of argon that flows into the system per unit time is $q\ X$.

If the volume of the circulatory system is V, the rate of argon increase is

$$\frac{d\,C_A}{dt} = \frac{q\,X}{V}$$

The concentration of NH_3 in the exit gas, C_X, is given approximately by

$$C_X = \frac{C}{1+\beta S}$$

where S is the space velocity and β a constant depending on the catalyst, temperature, and pressure.

Then $C_X = KC$

And $$\frac{X}{C} = \frac{X_O}{C'}$$

where X_O is the volume of gas flowing into the circulatory system when the equilibrium concentration is C' or when there is no argon in the system.

Thus $$\frac{dC_A}{dt} = \frac{q\,X_O\,C}{V\,C'}$$

From equation 2, differentiating with respect to time, combining, and integrating, we find

$$\log\frac{C'}{C} - \frac{1-C'}{\sqrt{C'}}\left(\frac{1\cdot\sqrt{C'}}{\sqrt{C'}} - \frac{1}{\sqrt{C}}\right) = \frac{qX_Ot}{C'V} \qquad (3)$$

This gives the value of C, which is proportional to the plant output as a function of time. For the plant conditions specified above, argon in the incoming gas = 0.304 per cent.

Then $q = 0.00304$, $V = 8$ cu.ft. and $X_O = 38.6$ cu.ft. per hour.

Equation 3 becomes

$$2.3\log\frac{1}{C} + \frac{0.767}{\sqrt{C}} - 2.402 = 0.0316t$$

This relation and the rate of decrease of conversion are shown in Fig. 3.

❖ ❖ ❖

A Stack Cover for Reaction Tanks

By F. C. Yokel
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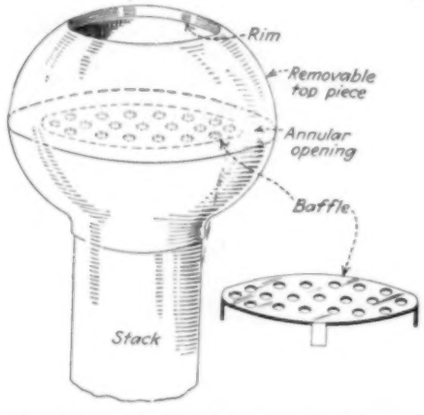
Los Angeles Chemical Company
Los Angeles, Calif.

WHENEVER a vigorous reaction is maintained within an inclosed tank, as in neutralizing an acid with lime or adding a salt to some hot acid, it is customary to cover the tank and employ a stack with a steam jet or ejector to remove the fumes. It is necessary to remove the fumes to protect the operator and to permit him to see into the tank to control the reaction. The stacks usually are open, with the result that considerable solid material is carried up and out the stack along with the fumes, and deposited on the roof and the adjacent neighborhood. This deposit certainly does not add to the attraction or appearance of the plant. Moreover, where acid materials are used they corrode the roof and building.

An ordinary stack cover will not suffice, as it probably will prevent the required draft up the stack which in time may become plugged with solids. Or it may deposit the material even more heavily on the roof near the stack. The device shown in the drawing has been found by the writer to serve adequately in every case needing a stack cover. All parts ordinarily will be made of lead. The top piece is removable, so that the baffle plate may be put in position. The latter is elevated by means of four legs, 3 in. in length. The width of this baffle plate may vary, depending upon the velocity of the fumes leaving the stack. Good results are obtained when the diameter of the baffle plate is 20 to 25 per cent more than that of the stack. The opening beneath the baffle must not be of less area than the stack.



Lead Cover for Preventing Stack Losses of Solids

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Improving Gage-Level Reading

IN A RECENT issue of *Maintenance Engineering* a simple method of improving the readability of manometers and gage glasses containing light-colored liquids is described. The method has the advantage of being as useful at night as it is in the daytime. It consists in providing a sheet metal shield through which the gage glass, or one or two legs of the manometer project. The shield is supported below the lowest point at which the level will have to be read. When a 25-watt incandescent lamp is lighted beneath the shield, some of the light passes into the tube and up the column of liquid. The entire tube is lighted, but where the beam strikes the meniscus it produces a lens effect, making the level readily visible at a distance of several feet.

❖

Reading Temperatures With Greater Accuracy

By A. J. Monack
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University of Illinois
Urbana, Ill.

A POTENTIOMETER scale can be read with only a certain accuracy; for instance, the closest readings may be within 0.05 millivolt of the true reading. With a chromel-constantan couple, which is used for measuring low temperatures with precision (0 to 360 deg. C.), the emf. generated at 100 deg. is approximately 5.5 millivolts, while at 0 deg. it is zero. The accuracy of the reading at 100 deg. then is 0.05 x 100/5.5, or 0.91 per cent. This presupposes that the external or "cold" junction is maintained at 0 deg. If the external junction is maintained at 200 deg. C., the emf. developed is approximately 14 millivolts when the internal junction is at 0 deg.; and approximately 9 millivolts when the internal junction is at 100 deg. If the external junction is maintained at 300 deg., the emf. developed is approximately 20 millivolts when the internal junction is at 0 deg. and approximately 13 millivolts when the internal junction is at 100 deg.

With the external junction at 200 deg. the accuracy of a reading at 100 deg. (internal junction) is 0.05 x 100/9, or 0.56 per cent; with the external junction at 300 deg. the accuracy is 0.05 x 100/13, or 0.38 per cent. At lower temperatures the accuracy is even greater, since the greatest accuracy is obtained when the internal junction is at 0 deg. This method may be used with combinations other than chromel-constantan and is especially useful for increasing the accuracy of low-temperature readings.

It is absolutely essential, of course, that the external junction be kept as nearly constant as possible. The following arrangement has been found to be satisfactory. The external junctions of seven thermocouples are located in a well-insulated box which contains a heating coil connected in series with a rheostat. This box is heated to 200 deg. and that temperature is maintained constant to within ±0.5 deg. (read with a mercury-in-glass thermometer) by means of a bimetallic thermostatic control of the ordinary type and a mercury relay. Care must be taken to see that the glass thermometer is not moved closer to or farther away from the heating coil, as this would change the temperature reading, which is to be kept constant. The connections between the external junctions and the potentiometer are made by means of copper wires and a seven-way switchboard.

EQUIPMENT NEWS
FROM MAKER AND USER

Multiple Cyclone Collector

UNDER THE DESIGNATION of Type 5, the Prat-Daniel Corp., 183 Madison Avenue, New York City, has announced a new multiple-cyclone dust collector, said to give higher efficiency than is obtainable from a single cyclone of comparable capacity. This consists of several small cyclones arranged for connection in parallel. The number to be used depends on the conditions, and this number, through the use of dampers, may be varied in any installation from time to time. The units are compact and, through the use of removable liners, are protected against high maintenance cost.

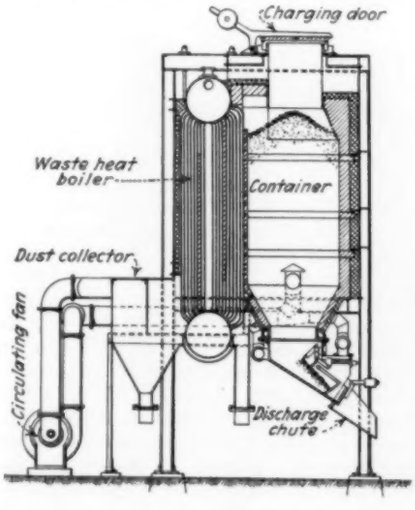
❖

Small Dry Quencher

DRY QUENCHING of coke in small and medium-sized gas plants is possible with an improved and entirely new type of unit, recently developed by the Dry Quenching Equipment Corp., 200 Madison Ave., New York. This unit, designated as Type B, is said to be readily adaptable to plants producing 20 to 80 tons of coke per day, with charges up to 2,500 lb. of coke. The principal features of the new unit appear in the accompanying drawing.

The unit consists essentially of a brick-lined container and a water-tube boiler, inclosed in a steel casing which forms a gas-tight housing. The tubes of the front row, forming one wall of the container, are faced with cast-iron blocks. Hot coke enters the charging door at the top of the container, and when cooled, passes from the discharge chute which contains a rake to regulate the rate of discharge. A gas-tight door prevents loss of circulating gas while the charging door is open. The charging door itself is of the water-sealed type, and is operated through a motor and speed reducer. A manually operated measuring device indicates on a scale the height of coke in the container. To prevent complete emptying of the container, discharge of the coke is automatically controlled so as to stop the discharge at a predetermined level.

Sectional View of New Dry Quencher for Small and Medium-Sized Gas Plants



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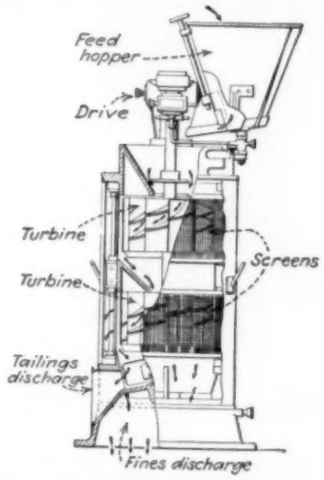
Turbine Sifter

LARGE SIFTING CAPACITY per unit of floor space is an important feature of the Blutergess turbine sifter, recently introduced into the United States by Abbé Engineering Co., 50 Church St., New York City. The principle of this machine may be explained in conjunction with the accompanying drawing, which shows the sifter partly in section. In brief, the sifter consists of a cylindrical screen within which rotates a turbine-like distributor which throws the material to be sifted against the screen cloth at high velocity. Since material strikes the meshes at an angle, the machine is capable of producing finer sizing than would be indicated by the size of the screen. The product, it is said, may be accurately controlled at any size between 4-6 mesh and 300 mesh or even finer.



New Turbine-Type Sifter for Fine Screening

Referring to the drawing, material to be sifted drops from the feed hopper into the upper turbine. In the turbine it is thrown by centrifugal force from the various compartments against the screens, the fines dropping down between the screen and the casing to the fines discharge, and the oversize dropping into a distributing cone and thence to the lower turbine. Here the same action takes place, with the exception that the oversize passes out the tailings discharge.

Among the features of this machine, the manufacturers claim very low operation cost, easy replacement of screen cloth, minimum wear on the screens, small floor space, complete freedom from clogging, low power consumption, and practically no upkeep. It is stated that the capacity of the sifter is more than that of a bolting reel occupying six times as much space, and that its power consumption is only about one-half.

❖

Stream-Line Filter

RIGHTS to manufacture and sell the Stream-Line Filter in North America have been acquired by Oliver United Filters, Inc., 33 West 42d St., New York City. This filter employs the principle of edge-filtration which has been described from time to time in *Chem. & Met.* See particularly *Chem. & Met.*, August, 1928, p. 497.

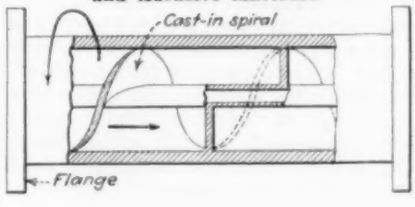
❖

Tubular Conveyor

MANUFACTURE of a rotary tubular conveyor for high-temperature work has recently been taken over by the Hardinge Co., York, Pa. This conveyor, previously marketed for use in smelters, is now being offered for all applications where hot and abrasive materials must be handled over considerable distances in a dustless manner. The conveyor consists of a series of tubular cast-metal sections containing a cast-in spiral. Any number of sections may be bolted together to produce a conveyor of the desired length. The longest installation at present is reported to be 270 ft. long, while 500 ft. now is considered the greatest practicable length. Sections are available in diameters from 7 to 24 in., for conveying from 5 to 100 tons per hour. Maximum recommended operating temperature is 1,000-1,200 deg. F.

At suitable intervals, supporting tires are attached between two conveyor sec-

Section of Spiral Conveyor for Hot, Dusty, and Abrasive Materials



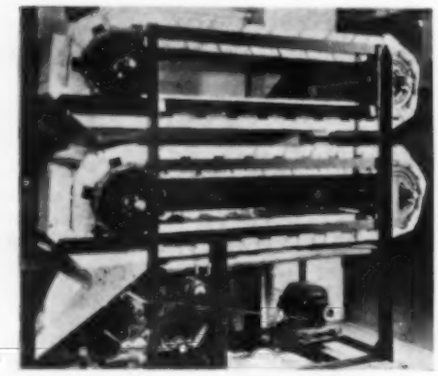
tions. The conveyor is then mounted on rolls and driven like a rotary kiln. At other suitable points, one or more feed sections may be inserted, and as many discharge points as are needed may also be connected. The accompanying drawing shows in cross-section the method of forming the internal spiral.

❖

Reversing Pan Dryer

IN AN EARLIER article in *Chem. & Met.* (p. 230, April, 1931) reference was made to a new reversing pan dryer recently developed by Proctor & Schwartz, Inc., Seventh St. and Tabor Rd., Philadelphia, Pa. A demonstration model of this machine is shown in the accompanying illustration. In actual operation, of course, the dryer is inclosed so that heated air may be blown between the pans and over the material contained in them to effect the necessary drying.

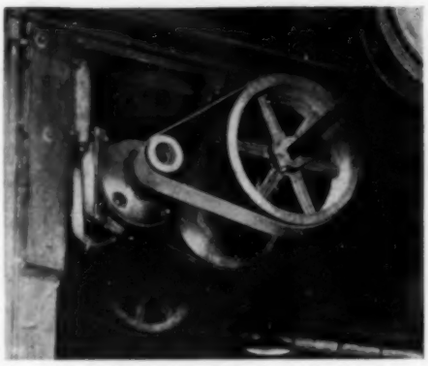
The heart of the new dryer is a special type of conveyor which is particularly adapted to the handling of large quantities of granular, free-flowing materials within a comparatively small space. As will be evident from the illustration, the dryer pans are set at about the angle of repose of the material to be dried, so that air can pass between the pans and over the solids,



Demonstration Model of Reversing Pan Dryer

while at the same time the overlapping mounting makes for very large capacity. End plates attached to the pans prevent the spilling of material at the sides, while use of distributing drums at the end of the upper runs permits dustless transfer of the solids from the top of the pans to the bottom of the same pans as they return. This double use of the pans not only doubles the capacity of the dryer but also results in the frequent turning of the material, thus speeding the drying. By varying the length and number of runs of conveyor, any capacity can be attained.

The pans, it will be observed, are made of riveted pressed metal, supported on roller chains, with the several runs driven in synchronism. The maker is prepared to supply these dryers in any construction material required by the process. The dryer is intended chiefly for materials ordinarily handled in truck and tray dryers.



Short-Center Belt Drive in Operation

Short-Center Belt Drive

IMPROVEMENT of its short-center, flat-belt drive has been announced by the Rockwood Mfg. Co., Indianapolis, Ind. The drive is now obtainable in six stock sizes from 1 to 50 hp. It consists of a special motor base, two special pulleys, and a flat leather belt of type approved by the company. Drives are designed for polyphase, 60-cycle a.c. motors of any make. The feature of the drive is that the motor is mounted on a free-swinging pivot, so that the weight of the motor maintains uniform belt tension at all times. According to the manufacturer, this principle results in the satisfactory use of a relatively low belt tension, giving maximum belt life and minimum strain on shaft bearings.

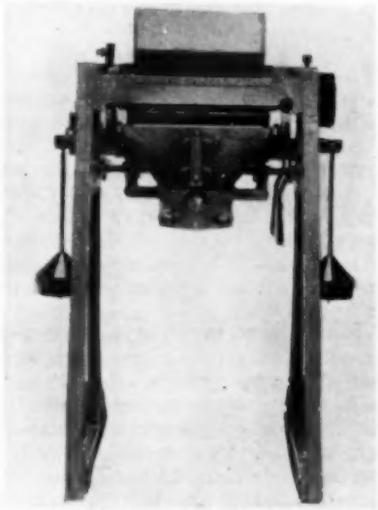
❖

Sacking Scale

WEIGHING and sacking of various materials, such as seeds, fertilizer, and numerous chemicals in powdered or granular form, are possible with a new low-headroom sacking scale, manufactured by the Richardson Scale Co., Clifton, N. J. The scale illustrated is of the stationary floor type. Other forms include portable floor scales and overhead stationary and portable types.

The scale consists of a chute with an undercut gate which controls the delivery of material from the chute to the bag. An agitator, driven by a belt, may be furnished, if necessary. The sacking spout and bag holder are supported from an even-arm balance which serves automatically to cut off the feed when the proper weight is in the bag. A single motion of a lever serves to clamp the bag to the holder and start the feed. Another motion serves to release the bag. Two operators, one attaching and one removing bags, are said to attain a speed of four to seven bags per minute, depending on the weight per bag and the type of material handled. Scales are available to weigh up to 200 lb.

Stationary Floor-Type Sacking Scale



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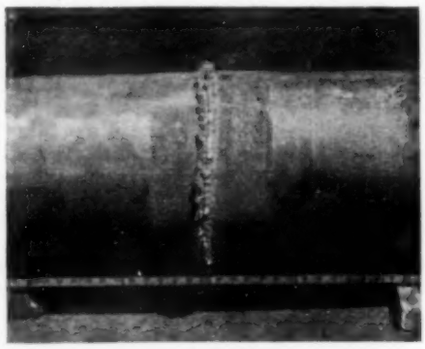
Resistance Pipe Welding

RECENT experimental work at the Barberton (Ohio) Works of the Babcock & Wilcox Co. has demonstrated that a large-diameter, heavy-wall pipe may be butt-welded successfully by the electric resistance method. The accompanying illustration shows a



Rough Resistance Weld in 14-In. Pipe

weld joining two short pieces of 14-in. O.D. x 1⅛-in.-wall seamless steel pipe. The company is now using this method for welding together tubes of small diameter and thin wall, as well as many intermediate sizes up to 14 in. Tests have shown that the welds are very satisfactory and that when a reasonable amount of flash is left inside and outside the pipe for reinforcement, the welded joint is stronger than the pipe itself.

❖

Compact Sampler

AS AN ADDITION to the line of Geary-Jennings automatic samplers for which the Galigher Co., Salt Lake City, Utah, is the sole agent, a new machine has been introduced which is smaller and more compact than the one described on page 645 of the October, 1930, issue of *Chem. & Met.* The maximum length of travel of the cutter used in this sampler is 24 in. and the minimum travel 15 in. It is designed especially for sampling the contents of launders from 6 to 20 in. in width. Among the improvements which have been introduced is a new timing switch which is operated by a Telechron motor. Another feature is the provision of

means tor sealing the cover in place to prevent the entrance of dust into the mechanism and to eliminate the possibility of tampering. The sampler may be provided with cutters adapted to the handling of wet materials from either launders or vertical chutes and for the sampling of dry materials.

❖

Flow Indicator

COMPACTNESS is a feature of a new flow indicator offered by Morey & Jones, Ltd., 922 South Hemlock St., Los Angeles, Calif. This consists of a direct-reading manometer which may be attached either directly or through lengths of connecting tubing to the flanges supporting an orifice plate in a pipe line conveying practically any commercial fluid. The instrument is supplied with scale plates 6, 12, or 18 in. long. It is equipped with a bypass valve and also with a ball check to prevent the possibility of blowing out the mercury. Indicators are regularly furnished for working pressures up to 250 lb., but can be built to handle any pressure to 2,000 lb. Special orifice flanges supplied by the company are adapted to the close-coupled mounting of this indicator.

❖

Cone Crusher

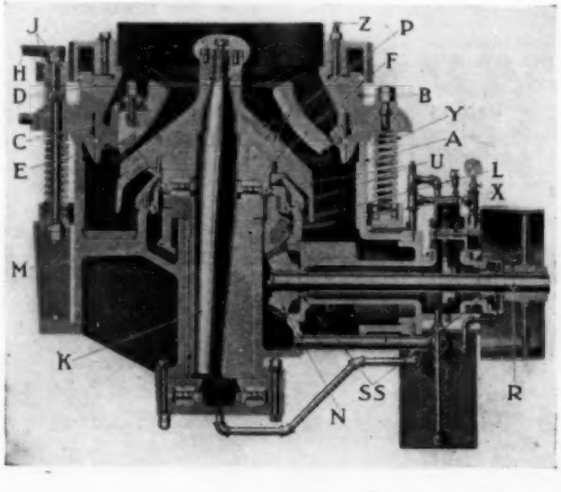
THREE SIZES of a new design of cone crusher, the Telsmith, have been announced by the Smith Engineering Works, Milwaukee, Wis. Depending on discharge size, these machines cover the range from 15 to 210 tons capacity.

An accompanying illustration shows a sectional view of the new crusher. A conical head, *P*, gyrates rapidly within a cone, *E*, so that every piece of rock is pinched several times while passing through, very little oversize being discharged. The head, *P*, is supported on an eccentric, *L*, which produces the gyratory motion as the eccentric revolves. The opening, and hence the finished size of the product, is adjusted by means of gears, *J*, which serve to lower *C*. Springs, *Y*, provide a flexible mounting for the upper crushing element to relieve choking due to overfeeding or tramp iron.

Depending on the size of the crusher, finished products may be discharged as fine as ½ to ⅜ in. Maximum feed size, also depending on the crusher size, is 3 to 7 in. Among the features of the crusher, the manufacturer mentions full forced-feed lubrication, anti-friction bearings throughout, ease of adjustment, large output, and freedom from choking and damage due to choking.

This company has also developed an improved jaw crusher which it is marketing under the name of the Telsmith-Wheeling crusher. This is an improvement of the crusher originally manufactured by the Wheeling Mold & Foundry Co., Wheeling, W. Va. It is a heavy-duty steel machine equipped with anti-friction bearings and a swinging jaw which is oscillated by an eccentric shaft to give a peculiar rotary crushing motion. The machine is made in four sizes with capacities from 3 to 36 tons per hour.

New Cone-Type Crusher Shown in Section



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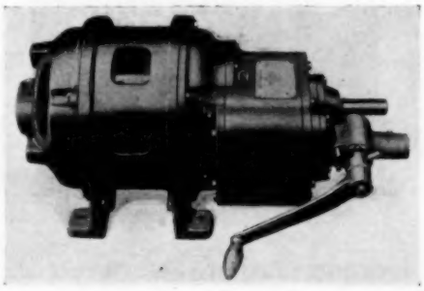
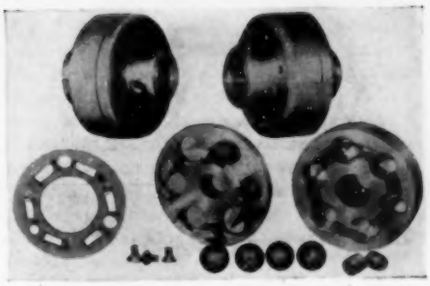


Westinghouse-Wise Multi-Speed Drive on an Induction Motor

Multi-Speed Drive

FOUR DIFFERENT SPEEDS at constant horsepower are obtainable from the output shaft of a standard a.c. motor through use of the new Westinghouse-Wise multi-speed drive recently announced by Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. The drive consists of a gear unit mounted on a standard squirrel-cage induction motor. The four gear sets are constantly in mesh and each is provided with an internal clutch actuated by two tapered wedges which are forced between the clutch halves by a spring member. This spring member runs through the hollow shaft on which the change gears are mounted. Its position is adjusted by means of a shift lever which is used in changing from one speed to the other. Movement of the lever disengages any clutch, puts the drive in neutral, and then engages the next clutch in the series so that any one may be selected at will.



Disassembled View of New Coupling

Flexible Coupling

NO LUBRICATION whatever is required by the Edmunds Coupling recently developed by Crocker-Wheeler Electric Mfg. Co., Ampere, N. J. Construction of the device is made clear by the accompanying halftone which shows the several parts that are assembled to make up the complete coupling. The flange section has six cylindrical pockets parallel to the shaft and a circular groove between pockets. The spider half has six projecting lugs between which are placed the rubber balls which act as resilient driving members. A cover holds the balls in place and is easily removed to permit replacement of the balls if this should become necessary. The manufacturers claim that the new coupling amply provides for misalignment and gives complete protection against shock loads.

❖

Improved Car Puller

ELECTRICAL OPERATION is provided by an improved car puller of the capstan type, recently announced by the Webster & Weller Mfg. Co., 1856 North Clostner Ave., Chicago, Ill. The device is said to be compact, economical, and easily operated. It is regularly built in three sizes to handle from 1 to 6 cars of 80 tons capacity.

❖

New Ceramic Materials

DEVELOPMENTS recently announced by the General Ceramics Co., 225 Broadway, New York City, include an armored stoneware centrifugal pump directly coupled to an electric motor. As the motor is provided with extra large and heavy bearings, the impeller is carried directly on the motor shaft, thus making a compact, self-contained unit. The acidproof stoneware housing of the pump is protected with a cast-iron shroud. Chemical stoneware is used for all parts coming in contact with the liquid being handled.

A second development is a new ceramic material called Ceramit, the outstanding characteristic of which is high density. Its coefficient of absorption is said to be only about 0.01 per cent, which is approximately that of porcelain. The material is said to have the advantage over porcelain in that it can be made into shapes impracticable for the latter, as its mechanical strength is higher and its resistance to changes in

temperature is not less than ordinary stoneware.

This company also has announced a new air-operated, automatic acid elevator consisting of only three parts. The device is made in five sizes ranging in capacity from 260 to 2,600 g.p.h. The only moving part is a completely inclosed ground and polished stoneware ball, which serves as a valve and has a lift of only a small fraction of an inch.

❖

Silent Back-Stop

POSITIVE prevention of shaft reversal on elevators and belt conveying equipment is the function of the new Landahl back-stop recently placed on the market by the Fairfield Engineering Co., Marion, Ohio. The construction of the device is such that it serves not only as a backstop but also as a bearing. It is installed to take the place of a standard type bearing, requiring no additional space. Internally, it consists of two locking pawls mounted on pins held by two floating rings and a pawl collar. All of these parts rotate as a unit by engagement of the pawls with the pawl collar. The latter is shaped so that the pawls do not engage the ratchet as long as the shaft is traveling in the correct direction, but lock in the ratchet immediately when the shaft direction reverses. Because of this discontinuous engagement, and because all working parts rotate in oil, the life of the device is said to be practically unlimited.

❖

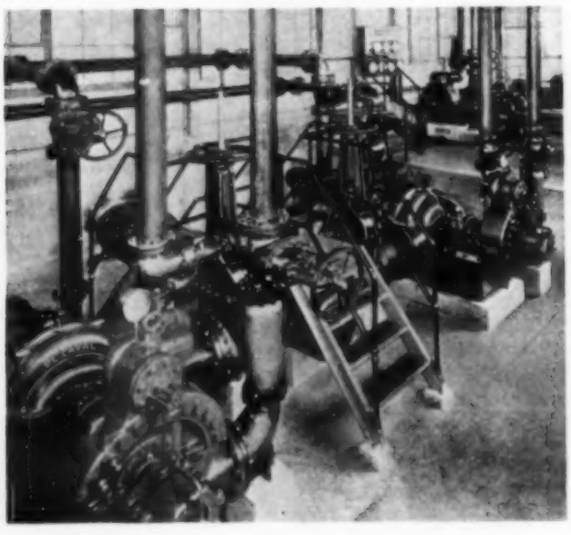
New Thermometer Tubing

TO COMPENSATE for temperature variations along the capillary tubing connecting the bulb and the instrument in mercury-filled thermometers, Taylor Instrument Co., Rochester, N. Y., have introduced a new self-compensating capillary tube which requires no added mechanism for accomplishing the compensation. Essentially, the new method consists in so proportioning the volume of mercury in the tubing to its coefficient of expansion and to the size of the alloy wire which runs through the tube that any change in the volume of the mercury resulting from external temperature changes is accurately compensated.

❖

Natural Gas Under Pressure Drives These Turbines

DeLaval Steam Turbine Co., Trenton, N. J., has developed turbines fitted with special nozzles to use natural gas under pressure instead of steam as a source of motive power. In this absorption plant in the Kettleman Hills field in California, natural gas is piped from the wells to the turbines, arriving at 275 lb. pressure. Gas is expanded in these turbines to 75 lb., at which pressure it is delivered to a customer. The gas is preheated with waste steam to approximately 190 deg. F. before expansion in the turbines.



Applying Buttonhole Tape to the Flange of a Large Tank

Unique Gasket

"BUTTONHOLE TAPE" is the name of a new gasket material of unique construction and method of application recently put on the market by the Garlock Packing Co., Palmyra, N. Y. The tape, on which a patent application has been made, consists of two parallel courses of Garlock folded asbestos, wire-inserted cloth joined together by a single ply of bonding fabric. In applying the gasket, the two parallel courses are separated at every point where a bolt is to go through, and for this operation it is only necessary to cut the bonding fabric for a short distance, forming a "buttonhole." The illustration clearly shows how this is accomplished. To simplify this perforation operation, the tape is furnished printed with 1-in. graduation marks. For joining two ends of buttonhole tape, the manufacturer recommends the use of a step joint. Tape is manufactured in coils of any desired length and in all regular widths and thicknesses.

Electro-Fabricated Tantalum

DEVELOPMENT of a new electroplating method of fabrication by the Fansteel Products Co., North Chicago, Ill., has made possible the production of copper-reinforced tantalum tubing and fabricated parts at lower cost than was heretofore possible in the production of tantalum apparatus. By the new process, the copper is deposited by plating either inside or outside a thin and comparatively inexpensive tantalum tube or other part, thus providing the necessary strength and rigidity with the common metal, while the tantalum lining or covering provides the desired protection against corrosion.

❖

24-Hour Pump Shipment

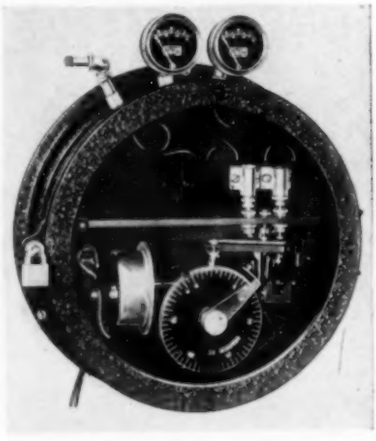
SHIPMENT within 24 hours of any pump in its new Flexi-Unit line of centrifugal pumps has been announced by Goulds Pumps, Inc., Seneca Falls, N. Y. These pumps comprise eleven standard pump units, with interchangeable impellers and nine universal bed plates for mounting any size of motor from ¼ to 50 hp., with speeds of from 1,450 to 3,450 r.p.m. From these parts 150 pumping combinations can be produced for capacities from 10 to 1,100 g.p.m. at heads up to 350 ft.

❖

Adjustable Timer

WHEREAS in the usual timers for vulcanizers, the cam operates only in one direction at a rate of speed depending on the gearing which connects it to the clock, in the new timer made by the C. J. Tagliabue Mfg. Co., Brooklyn, N. Y., a reversible electric clock is employed which revolves the cam in one direction during the first half of the cure, whereupon it automatically reverses and turns the cam in the other direction until the zero point is reached. Here it again reverses and immediately stops. To change the length of cure, it is only necessary to make a simple adjustment of the reversing arm, requiring only a few seconds. This is facilitated by the fact that the cam is graduated in minutes. The venting

New Air-Operated Timer With Reversible Electric Clock



period of the tube is controlled by a separate fully adjustable cam sector. Other functions are controlled by non-adjustable cams, as the timing of these operations remains constant regardless of changes in the length of cure.

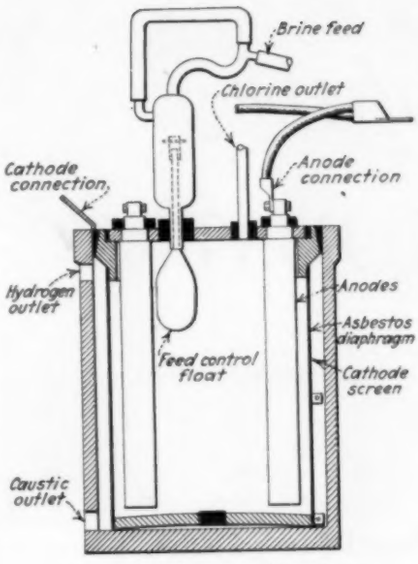
This company also has announced a new industrial thermometer which features a snap-on case front. This facilitates cleaning of the glass.

❖

Stoneware Equipment

CHEMICAL stoneware equipment recently announced by the U. S. Stoneware Co., 50 Church St., New York City, includes an electric Tumbelmixer and a new laboratory-size electrolytic cell for chlorine and caustic soda. The Tumbelmixer consists of a stoneware container of barrel shape provided with trunnion bearings journaled in a supporting framework. A small motor driving through a reduction mechanism operates the mixer at a recommended speed of 50 to 60 r.p.m. The machine is recommended for both wet and dry mixing, and for both acid and alkaline materials. Four sizes range from 10 to 25 gal. in capacity.

The electrolytic cell shown in the accompanying drawing is of the Vorce type, duplicating the performance of the standard 1,000-amp. Vorce cell previously described in *Chem. & Met.* (March, 1928, p. 158). It is made in one size, 11 in. O.D., for current rates varying between 150 and 50 amp.



Cross-Section of Laboratory Electrolytic Cell

Manufacturers' Latest Publications

Air Handling. B. F. Sturtevant Co., Hyde Park, Boston, Mass.—Publications as follows: Catalog 383, Humidifilter air-conditioning unit; Bulletin 384, suspended type air-conditioning unit; Bulletin 385, new propeller fan made by this company.

Bearings. Aetna Ball Bearing Co., 4600 Schubert Ave., Chicago, Ill.—Catalog, 9th Edition—68 pages in handbook form on complete line of ball and roller bearings.

Bimetals. H. A. Wilson Co., 97 Chestnut St., Newark, N. J.—16 pages of information on the thermostatic metals made by this company, including description, formulas, and curves.

Burners. Denver Fire Clay Co., Denver, Colo.—Bulletin 305-A—10-page illustrated booklet on Type A refractory gas burners for industrial furnaces.

Burners. Fuller Lehigh Co., 85 Liberty St., New York City—Bulletin 905—4 pages on a circular burner for pulverized coal.

Burners. Lee B. Mettler Co., 406 S. Main St., Los Angeles, Calif.—Folder briefly commemorating achievements of this company.

Burners. National Airoil Burner Co., 1327 Girard Ave., Philadelphia, Pa.—Publications as follows: Bulletin 22, how to install steam atomizing oil burners; 30, oil burner accessories; 50, oil and gas combustion units; 60, indirect rotary oil burners; 70, direct rotary oil burners; "Oil Burning Efficiency; also booklet on oil burning in power plants.

Chemicals. Reilly Chemical Co., Indianapolis, Ind.—18 pages briefly describing the facilities of and coal-tar products made by this company.

Chemicals. Roessler & Hasslacher Chemical Co., Niagara Falls, N. Y. — 32-page quarterly price list of more than 200 chemicals made and sold by this company. Includes data on specifications, properties, specific applications, containers, and prices.

Cracking. Universal Oil Products Co., 310 S. Michigan Ave., Chicago, Ill.—Two reprinted articles: "The Cracking Process in the Gas-Making Industry" and "Importance of Cracking Equipment in the Modern Refinery."

Disintegration. Pulverizing Machinery Co., 30 Church St., New York City—26-page loose-leaf folder describing this company's "Mikro-Pulverizer" and explaining the application of this machine in several industries.

Disintegration. The Wolf Co., Chambersburg, Pa.—Bulletin H 1—8-page booklet on the horizontal and upright crushers made by this company.

Drying. Western Precipitation Co., 1016 W. 9th St., Los Angeles, Calif.—8-page booklet describing and illustrating the Peebles Spray Drying System.

Electrical Equipment. The Louis Allis Co., Milwaukee, Wis.—Bulletin 500-A—16-page booklet on multi-speed squirrel-cage alternating-current motors, Type M, ½ to 150 hp.; Bulletin 508-A, 12 pages on explosion-proof self-ventilated squirrel-cage motors for hazardous atmospheres.

Electrical Equipment. U. S. Electrical Mfg. Co., Los Angeles, Calif.—6-page folder describing the constructional features and advantages of a vertical, inclosed motor made by this company.

Electrical Equipment. Wagner Electric Corp., 6400 Plymouth Ave., St. Louis, Mo.—Bulletin 165—Discussion of seven types of squirrel-cage motor, comparing starting torques, starting currents, and costs.

Electrical Equipment. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.—Circular 1907—16 pages on a new line of steel-tank mercury-arc rectifiers; Circular 1908, 12-page booklet on small generator units and their applications; Leaflet 20385-A, 4 pages on Type CS squirrel-cage induction motors.

Emulsions. Glyco Products Co., Bush Terminal Bldg., No. 5, Brooklyn, N. Y.—8-page folder on theory and practice of emulsions, including working formulas for several products.

Equipment. F. J. Stokes Machine Co., Olney P. O., Philadelphia, Pa.—Catalog 31—48-page illustrated catalog describing a wide variety of process equipment made by this company.

Evaporation. Swenson Evaporator Co., Harvey, Ill.—Catalog E-131—42-page book describing evaporators and auxiliary equipment made by this company; includes tables and charts of useful information.

Filter Paper. Carl Schleicher & Schüll, 167 E. 33d St., New York City—62-page booklet describing a large number of types of filter paper; also includes samples.

Foundry Sand Testing. Harry W. Dietert Co., 676 W. Grand Blvd., Detroit, Mich.—Catalog 102 — Describes and illustrates equipment for testing foundry sand.

Furnaces. W. S. Rockwell Co., 50 Church St., New York City—Folder briefly describing a continuous heat-treating furnace using a novel form of sectional conveyor.

Grease Making. Sowers Mfg. Co., Buffalo, N. Y. — Discussion No. 4 — 8-page article on the making of soda soap grease, being a technical discussion with illustrations of the various types of equipment used for the several steps.

Heating Elements. Harold E. Trent Co., 618 N. 54th St., Philadelphia, Pa.—Leaflet TA-30—4 pages on electric strip heaters made by this company.

Heat Transfer. Griscom-Russell Co., 285 Madison Ave., New York City—Form 479—8 pages on several types of heat-transfer equipment intended for the chemical industry. Includes condensers, coolers, heat exchangers, heaters, and evaporators.

Instruments. The Brown Instrument Co., Philadelphia, Pa.—Catalog 1101—48 pages on a new line of potentiometer pyrometers recently introduced by this company; describes the instrument in its various forms and also auxiliary equipment.

Instruments. Esterline-Angus Co., Indianapolis, Ind. — Bulletin 431 — Describes the use of graphic instruments in finishing plate glass.

Instruments. The Foxboro Co., Foxboro, Mass.—Bulletin 168—24 pages on the steel-spring recording pressure gages made by this company.

Instruments. The Neilan Co., Ltd., 641 Santa Fe Ave., Los Angeles, Calif.—Bulletin 4050-B—8-page booklet describing differential and pressure limit controllers made by this company.

Jacketed Pipe. Parks-Cramer Co., 1102 Old South Bldg., Boston, Mass.—Leaflet briefly describing jacketed pipes and fittings for the conveyance of materials which tend to solidify at normal temperatures.

Kilo Conversion Book. C. W. Kenick, Cunard Steamship Co., Ltd., 25 Broadway, New York City—Tables for conversion of kilos to pounds in steps of 1 kilo from 1 to 1,000 kilos; free on application.

Laboratory Equipment—Central Scientific Co., 460 E. Ohio St., Chicago, Ill.—New bulletins describing Sillimanite ware, drying ovens, balances, hot-cone heaters, and air-cooled rotary blowers and vacuum pumps made by this company.

Materials Handling. Lewis-Shepard Co., Watertown Station, Boston, Mass.—Circular 58—Folder illustrating a very wide range of lift trucks and stackers made by this company.

Metals and Alloys. Michigan Steel Casting Co., 1986 Guoin St., Detroit, Mich.—Bulletin 5—4 pages on Misco C, a cast alloy resistant to sulphite acids without special treatment.

Metals and Alloys. Subsidiary Manufacturing Companies, U. S. Steel Corp., Frick Building, Pittsburgh, Pa.—35-page illustrated book, giving specifications and uses of Stainless and heat-resisting alloy steels, manufactured by five subsidiary companies of U. S. Steel Corp.

Odorization. Pacific Pipe & Supply Co., 1002 Santa Fe Ave., Los Angeles, Calif.—Folder describing the Papico natural gas odorizing system.

Ovens and Dryers. Freas Thermo-Electric Co., 1206 S. Grove St., Irvington, N. J.—48-page catalog on industrial ovens and dryers with sections devoted to "Electric Heat vs. Fuel Heat" and the basic principles of electric ovens and dryers.

Paper Stock. Tolhurst Machine Works, Inc., Troy, N. Y.—Booklet describing and explaining a centrifugal paper-stock cleaner recently developed by this company.

Piping. Tube-Turns, Inc., Louisville, Ky.—Bulletin 106—Folder giving design data for producing expansion loops by welding together sections of straight pipe and the Tube-Turns made by this company.

Power Transmission. L. H. Gilmer Co., Tacony, Philadelphia, Pa.—84-page catalog on V-belts, including a section on advantages and uses of such drives, and a section devoted to tables of engineering data.

Power Transmission. D. O. James Mfg. Co., 1120 W. Monroe St., Chicago, Ill.—Catalog 136—96-page book describing, illustrating, and giving engineering data on continuous-tooth herringbone speed reducers, back-stops, couplings, and continuous-tooth herringbone cut gears.

Power Transmission. Morse Chain Co., Ithaca, N. Y.—Bulletin 40—Folder describing midget flexible couplings.

Pumps. Morris Machine Works, Baldwinsville, N. Y.—Bulletin 139—15 pages with illustrations and data on non-clogging centrifugal pumps for sewage and industrial services.

Pumps. Worthington Pump & Machinery Corp., Harrison, N. J. — Publications as follows: W-312-S4, W-312-S5, W-312-S7, W-312-S8, covering single-stage volute centrifugal pumps; D-112-S13, horizontal duplex double-plunger steam pumps.

Refractories. E. J. Lavino & Co., Bullitt Bldg., Philadelphia, Pa.—6-page folder describing the properties of Kromepatch bonding cement and its use for various purposes.

Slide Rule. J. R. Dempster, 2204 Glen Ave., Berkeley, Calif.—4-page folder describing the Rotarule, a circular 50-in. pocket slide rule.

NEWS *of the* INDUSTRY

Gas Men Discuss Various Production Problems

NUMEROUS production and gas-mixing problems of public-utility gas men were considered in detail at the joint production and chemical conference of the American Gas Association held in Philadelphia, May 20 to 22. The dominating factor throughout the six sessions of this conference was adjustment of the fuel-gas industry for the utilization of new sources of gas or new raw materials for manufacture. Elsewhere in this issue of *Chem. & Met.* is a staff interpretation of the problems which are being studied as the petroleum, natural-gas, and manufactured-gas industries are drawn closer together by these developments.

Other papers presented at the conference which have chemical-engineering interest were, among others, the following: (1) coke treatment, by E. W. Zimmerman, a discussion of rendering coke dustless by treatment with calcium chloride or by other patented treating agents; (2) a preliminary subcommittee report on factors affecting the credit now obtainable for byproduct ammonia, presented by R. S. McBride, chairman of the sub-committee on ammonia economics; (3) some protective coating systems for reducing external pipe corrosion on transmission mains, by H. A. Gardner, director of the Institute of Paint and Varnish Research, including particularly one suggested pipe-coating system and a system of application believed to afford great durability; (4) process for the reduction of the organic sulphur in city gas, described by E. J. Menery, a process for preheating city gas in contact with a catalyst to convert the organic sulphur compounds to hydrogen sulphide, permitting easy removal with customary oxide methods; the industrial situation requiring this development was the prevention of "bloom" on manufactured glassware in a gas-fired lehr for annealing glassware under circumstances causing "bloom" during the period of annealing exposure if more than 2.7 grains of sulphur per 100 cu.ft. was present in the gas; (5) the Girdler process for gas purification, using diethanolamine or triethanolamine for both CO_2 and H_2S, as described by R. R. Bottoms; (6) cooperative investigations with the Bureau of Mines on odorizing of non-odorous gas supplies as reported by P. H. Gadsden, chairman of the A.G.A. commission on asphyxiation and resuscitation; Mr. Gadsden described the preliminary results obtained with croton aldehyde, chloracetophenone, ethyl mercaptan, pyridine, amyl acetate, butylene, etc., and pointed out the desirability of further experience on practical city-wide systems before formulating conclusions.

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Naval Stores Station For Florida

THE Naval Stores Experiment Station of the U. S. Department of Agriculture's Bureau of Chemistry and Soils, for which the last Congress appropriated $40,000, for which ten cities and localities in Georgia and Florida recently offered free sites and facilities, will be located in the Osceola National Forest at Olustee, Fla., according to an announcement by Dr. Henry G. Knight, Chief of the Bureau of Chemistry and Soils.

One consideration which guided the committee in the selection of Olustee is its accessibility to naval-stores producers of Georgia and Florida by good roads and railroads. The town is only 12 miles from Lake City, a railway center where mechanical service and supplies are available. Also, the area surrounding Olustee contains several different types of soils and has a large available supply of gum from each of the turpentine-yielding pines, approximately 50 per cent longleaf and 50 per cent slash, which will enable thorough study of the gums and the development of products.

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Dorr-Oliver Corporation Unites Old Companies

ANNOUNCEMENT has been made of the union of the business and assets of the Dorr Company and Oliver United Filters, Inc. This union was brought about on June 1 by the formation of a new company, to be known as Dorr-Oliver Corp., under the joint management of Messrs. Dorr and Oliver.

Dorr-Oliver Corp. will function through its two wholly owned operating units, a new Dorr Co., Inc., and a new Oliver United Filters, Inc. John V. N. Dorr and Edwin L. Oliver will head their respective companies and with the aid of their present executive and technical staffs, will continue, on behalf of Dorr-Oliver Corp., the business which they have individually initiated, organized, and expanded so successfully in the past.

Lime Association Told Of New Developments

A NEW method of sewage treatment embodying the use of lime in combination with chlorine was described at the annual convention of the National Lime Association, June 4, at White Sulphur Springs, W. Va., by W. V. Brumbaugh, the association's assistant secretary. Designated as the lime-chlorine process, this new idea was developed by L. H. Enslow, of the Chlorine Institute, and Mr. Brumbaugh reported that this research definitely indicates an increased efficiency in sewage chlorination if the chlorine is applied in combination with lime.

Mr. Brumbaugh stated that the new process can be effectively applied to every city and town now treating sewage by any of the standard methods. Dayton, Ohio, is now installing the process for the purpose of odor control. Middletown, N. Y., is planning to adopt the method to eliminate slime-deposition on the surface and beds of streams. The process is now being used in Baltimore for the sole purpose of arresting the development of algae in tidal waters. At the present rate of application for this purpose, from 290 to 385 tons of chlorine and from 360 to 480 tons of lime will be required annually.

Two papers—one theoretical, by L. A. Palmer, research associate of the American Face Brick Association at the U. S. Bureau of Standards, and one practical, by Stanley Newman, waterproofing engineer of Boston—indicated that efflorescence and leaky walls could be overcome by using mortars of high lime content. The association's budget must be trimmed to meet the decline in the business of its members during 1930, but because of the importance of Mr. Palmer's research work, it is probable that the association will help to finance continued research for determining the properties of mortar.

The reelected officers of the association are Norman G. Hough, president and general manager; R. P. Wilton, secretary-treasurer; and W. V. Brumbaugh, assistant secretary-treasurer. New members elected to the board of directors are C. C. Loomis, New England Lime Co., Pittsfield, Mass.; Philip L. Corson, G. & W. H. Corson, Inc., Plymouth Meeting, Pa.; James H. McNamara, Eagle Rock Lime Co., Eagle Rock, Va.; and R. E. Tremoureux, United States Lime Products Co., San Francisco, Cal.

Manufacturing Chemists In Annual Session

IN OPENING the annual meeting of the Manufacturing Chemists' Association at the Seaview Golf Club, Absecon, N. J., on June 4, President Lammot duPont made a strong plea for greater confidence, respect, and trust among the producers of chemicals. The recent and disastrous price wars in the alkali and alcohol trades would never have occurred, he declared, if the men involved had only acted like normal human beings. Distrust breeds suspicion and unfair business dealings. Without any attempt to evade even the spirit of the anti-trust laws, which Mr. duPont believes have been extremely beneficial, there is nevertheless an opportunity in the association for competitors to become better acquainted and therefore more likely to work in the best interest of chemical industry as a whole.

Salmon W. Wilder, retiring chairman of the executive committee, presented the annual report summarizing the year's activities. Chief among these has been the work of the technical committees, notably those on carboys, barrels and drums, tank cars, and traffic; the expansion of the service rendered by the Washington office under the direction of Warren N. Watson, secretary; and the institution of legislative bulletins of state and federal bills relating to chemicals and allied products. Attention was called to the distinguished service rendered by Dr. Charles L. Reese and William H. Bower, who retired from the executive committee during the past year.

M. C. A. Officers at Seaview
Reading Left to Right, E. M. Allen, H. L. Derby, Lammot duPont, S. W. Wilder, and W. D. Huntington.

An interesting feature of the meeting was a popular address by Dr. William J. Hale, of the Dow Chemical Co., entitled "This Chemical Revolution." With characteristic fascination he pictured the place that organic chemistry will some day take in our national economy, urging particularly that chemical industry form an alliance with agriculture to promote the more efficient use of the basic raw materials of Nature. His remarks are reported in greater detail on pages 349 and 350 of this issue.

W. D. Huntington, Chairman, Discusses Business With Warren N. Watson, Executive Secretary

Senator Henry D. Hatfield was the principal speaker at the annual banquet, over which E. H. Killheffer presided as toastmaster. In introducing the Senator, Mr. Killheffer reminded the audience of the valuable service to chemical industry which Dr. Hatfield had rendered in his vigorous effort to secure adequate tariff protection. The speaker sketched the importance of chemical industry to his own profession, medicine; to his own state, West Virginia; and to the welfare of the entire country. He urged the continuation of research as the means of maintaining America's leading position in the chemical industry of the world.

New officers elected by the association are as follows: Lammot duPont, president; W. B. Bell, vice-president; E. M. Allen, vice-president; J. W. McLaughlin, treasurer; and Warren N. Watson, secretary. W. D. Huntington succeeds Mr. Wilder as chairman of the executive committee, which now includes Charles Millard, H. L. Derby, T. E. Doremus, L. T. Beale, George Merck, and Charles Belknap.

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Bromine Production Will Be Increased

THE Dow Chemical Co. has purchased a large tract of land near Wilmington, N. C., which it will use as a site for a plant for the extraction of bromine from sea water. Associated with the Dow company in this project is the Ethyl Gasoline Corp., whose plant adjacent to the new bromine works will utilize ethylene dibromide in the production of anti-knock compounds for the petroleum industry.

Technical and Engineering Exhibits in Japan

THREE exhibitions representing recent technical and engineering developments in Japan were opened this year in Tokyo and Osaka, according to a report from Consul Leo D. Sturgeon, Tokyo, made public by the Department of Commerce. They were the Third Chemical and Industrial Exhibition, the Precision Apparatus Exhibition, and the New Inventions Exhibition. About eight hundred firms and institutions participated in the Chemical and Industrial Exhibition, showing more than 60,000 kinds of chemical and industrial products which show marked advances over the products exhibited in the 1926 exhibition. Modern manufacturing processes for such products as smokeless powder, special apparatus for astrophotography by the Astronomical Observatory of Tokyo, and a wide array of chemicals produced by the iron and gas industries were features of the exhibition.

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Cheap Alloy Sought for Turpentine Cups

THE naval stores industry needs a durable and inexpensive cup for gathering turpentine gum, a cup which with neither rust nor discolor the gum. At the request of the Pine Institute of America, chemists of the U. S. Department of Agriculture have been testing cups made from various substances and of several alloys. The Bureau of Chemistry and Soils reports that several months of investigation have not yet revealed a cup material which is both inexpensive and satisfactory, but that the search will continue. Some of the alloys tested resist the chemical action of water and turpentine gum, and do not discolor the gum objectionably, but these alloys are too expensive. Cups made of 26-gage plate, the investigators say, would cost about 25 cents each, or $2,500 for a "crop" of 10,000 cups, an expense which producers cannot undertake.

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Trade Practice Codes Submitted

EIGHTY trade practice codes were returned early this month to the industries which framed them, with the changes proposed by the Federal Trade Commission to forestall possible infractions of the anti-trust laws. The industries which received their revised codes this month have 60 days in which to accept them, after which, according to an announcement by the Commission, they will become effective in their revised form. The codes which have been revised and returned to date include those relating to beauty and barber supplies, edible oil, fertilizer, gypsum, insecticides and disinfectants, lime, medical gas, naval stores, paint, varnishes and lacquer, and solvents.

NEWS FROM WASHINGTON

By Paul Wooton

Washington Correspondent of Chem. & Met.

REGULATION of the sale of all poisonous volatile substances under a criminal statute is proposed in legislation drafted by Prof. Yandell Henderson, Yale professor of applied physiology, for introduction in Congress next December by Senator Bingham, of Connecticut. The bill provides for the confiscation of any product of this character which is not covered by a permit issued by the Secretary of Agriculture or does not bear a "poison" label giving direction for treatment in case inhalation of the fumes results in injury. A statement also would be required on the label describing the conditions under which inhalation would be particularly dangerous.

The bill does not prohibit the manufacture or sale of any products that may be useful but is intended, according to Prof. Henderson, to protect the general public against the hazards to health and life when poisonous volatile substances, such as methanol, methyl chloride, benzol and tetra ethyl lead, are used improperly by persons ignorant of their danger. To this end the bill provides that the Secretary of Agriculture shall have analyses and other scientific examinations made of all volatile poisonous substances or mixtures entering interstate trade, and that with the advice of a board of eminent scientific men, the Secretary shall define the conditions with respect to labeling and sale. Shipment of any poisonous volatile substance without a permit or without a proper label, and alteration, mutilation, or removal of the label is punishable by a fine or imprisonment.

Nominations for membership on the advisory board would be made by the National Academy of Sciences, the National Research Council, the American Chemical Society, Federation of American Societies for Experimental Biology, and similar national scientific organizations. The members of this board would serve without pay except for per diem compensation of $20 for attending the semi-annual or other meetings upon call of the Secretary of Agriculture.

THE provisions of the bill would not apply to common carriers, exporters, or to dealers who can produce a guaranty to the effect that the wholesaler, jobber, or manufacturer has complied with the act. Imports of any poisonous volatile substances would be subject to exclusion, under the terms of the bill, unless they are labeled so as to conform to the law. The bill provides that if any person is injured or dies as a result of a violation of its provisions by any other person, the injured party or the estate of the deceased may sue for compensation in a federal district court.

Senator Bingham expressed the belief that legislation of this kind is greatly needed to reduce the hazards caused by recent inventions and those that may be expected in the future. Senator Bingham was an associate of Prof. Henderson at Yale. Prof. Henderson has long been active in studying the effects of various gases and crusaded a few years ago against the use of tetra ethyl lead in gasoline. He is also credited with the introduction of the now standard inhalation treatment for carbon monoxide poisoning and is a member of the American Medical Association's committee on poisonous gases.

In a letter to Senator Bingham, Prof. Henderson states that the bill will be of great value not only in interstate trade but as a model for similar legislation by the states. Pointing out that the federal government now gives effective supervision to food, drugs, and caustic poisons, Prof. Henderson states that neither the federal nor state governments have as yet enacted legislation to prevent the so-called accidents from exposure to various gases and vapors which still takes a toll of lives and injures wholly innocent people.

REFERRING to the current investigation being made by the Bureau of Mines concerning the toxicity of methanol, the expense of which is defrayed in part by the manufacturers, Prof. Henderson states: "It is certainly better that the matters should be investigated in this way than not at all, for the officers and scientists of the Bureau of Mines are men both of unquestionable integrity and technical capacity, but on several grounds objections have recently been raised to such a relation between a government agency and an interested party in a controversy affecting the public health."

The Bingham bill is regarded as the most far-reaching and drastic legislation that has even been proposed affecting the chemical industry. It elaborates on the Federal Caustic Poisons Act and is applicable, in theory at least, to practically all chemical products that emit any fumes whatever. The provisions of the bill will be carefully studied this summer by the Manufacturing Chemists' Association and other organizations which are apprehensive that such a law would thrust upon all solvents the burden that the manufacturers and users of industrial alcohol have had to bear since enactment of the prohibition law.

Current agitation concerning the use of methanol as an anti-freeze is accepted as the inspiration for the legislation that Senator Bingham proposes to introduce. It is much broader in its terms, however, than other bills that have been put forward in Congress and in the state legislatures to regulate the sale of methanol.

Pending completion of the investigation by the Bureau of Mines into the toxicity of methanol fumes, emphasis has shifted to setting up safeguards to prevent the drinking of methanol, either because of ignorance or by mistake. Representatives of the methanol manufacturers, in conference with officials of the U. S. Public Health Service, have agreed, in general, to accept any recommendations that the federal agency may suggest for protecting the public against the hazard involved.

OUTBOUND tonnage from the United States Potash Co.'s development in Eddy County, N. M., is estimated by the Atchison, Topeka & Santa Fe Ry. at 100,000 tons of manure salts and 125,000 tons of refined potash during the first year after construction of its five-mile branch line from Loving. The road also has advised the Interstate Commerce Commission that the potash company is planning, as soon as building material can be brought in, to start construction of a refinery and of a narrow-gage road approximately 16 miles in length extending from the refinery site to the mine shaft. Construction of the Santa Fe's branch was authorized by the Commission on June 4.

The combined tonnage of crude crushed mineral rock fertilizer and refined potash will increase, according to the Santa Fe's estimates, to 281,250 tons in the second year, 337,500 tons in the third year, 393,750 tons in the fourth year, and 450,000 tons in the fifth year, when daily production is expected to reach 1,500 tons. The Santa Fe points out in this connection that annual domestic consumption of potash approximates 270,000 tons. In support of its application to construct the branch line the road states that it anticipates a profitable volume of traffic for an indefinite period of time, as core tests in the area leased by the potash company indicate a potential body of 200,000,000 tons of silvite ore.

The road reports that at present the potash company is trucking crude potash from the mine shaft over 22½ miles of graded dirt road and highway to Carlsbad, the nearest available railway station. The Santa Fe branch will extend from a point on its existing line near Loving, only five miles distant from the site of the proposed refinery.

Construction of the branch line will begin as soon as authorized by the Commission and will be completed within six months, according to the Santa Fe. The average freight rate per ton is estimated at $10 on manure salts shipped from the refinery to the territory embracing Virginia, North Carolina, South Carolina, Georgia, Alabama, Florida, Mississippi, Tennessee, Kentucky, and Louisiana. The average rate on refined potash is estimated at $8.10 to territory embracing Louisiana, Tennessee, Missouri, Iowa, Illinois, Wisconsin, and Minnesota.

British Chemical Stocks Unduly Affected by Depression

Reduction in Bank Rate May Mark Definite Turning Point

From Our London Correspondent

THE market value of chemical stocks and shares has been unduly affected by the general financial depression; forced selling has, for instance, brought down the price of Imperial Chemical stock to very little over $2 for a $5 share. This is out of all proportion to the intrinsic value, the actual cash reserve, and the ultimately indispensable nature of the business, so that it is reasonable to think that the low-water mark must at last have been reached. The reduction in the bank rate to 2½ per cent and other financial "straws" probably will mark a definite turning point rather than break the camel's back.

The oil companies are withstanding the strain remarkably well, probably on account of the conservative financial policy pursued in the past. There seems little hope of any material increase in the price of oil or gasoline, and for that reason it seems clear that there can be no future of serious magnitude for the hydrogenation of coal in this country on a commercial scale, however attractive it may be to hold out this possibility. In England the panic mongers cannot readily get away with the idea that such an industry is essential for national safety, seeing that the food question is paramount, and there is adequate storage capacity for oil. Nevertheless, a certain amount of encouragement is definitely promised by the government, which is to make a start with the use of low-temperature oils for the navy, to experiment with powdered fuel in the merchant marine, and to encourage the use of low-temperature smokeless fuel in all government and municipal departments. The determining factor for the hydrogenation of coal has been the cost of hydrogen, but more recent developments indicate that it will be quite feasible to generate the hydrogen required during the process cycle itself and without separate plant.

THE new president of the Society of Chemical Industry is to be Prof. Gilbert T. Morgan, F.R.S, who is head of the Chemical Division and High Pressure Research Laboratory at the National Physical Laboratory, Teddington, under the Department of Scientific & Industrial Research. Prof. Morgan has no equal in this country as an organic and dyestuffs chemist and probably is one of the clearest thinkers, most competent administrators, and straightforward personalities in this country. Although it is perhaps a little difficult to follow on after Lord Melchett and Sir Harry McGowan, it is quite safe to expect great things of Prof. Morgan, particularly as he has such a happy knack of obtaining universal support and collaboration from the somewhat heterogeneous assortment of members composing the Society of Chemical Industry.

The issue of that society's Journal of May 1 includes about 20 pages of reviews and notices of technical books and forthcoming publications and is well worthy of study. As regards the Chemistry House scheme, this is jeopardized by the present financial and commercial depression, because obviously the subscriptions of individual members of the Association of Scientific and Technical Institutions sometimes nicknamed "Asti Spumante" can represent only a small percentage of the total sum required. The Association of British Chemical Manufacturers has organized a British chemical standardizing body under the chairmanship of Dr. E. F. Armstrong. Some twelve years ago the idea of chemical engineering standardization was first mooted and proposals were drawn up, as the result of which the British Engineering Standards Association made a half-hearted start with the support of representatives appointed by the Society of Chemical Industry and the Chemical Engineering Group. The present scheme is rather more ambitious and is the result of the patient education of the powers that be, by chemical engineers and other enthusiasts, who, as usual, were rather far ahead of their time.

ANNOUNCEMENT has been made that Chemical & Wood Industries, Ltd., which was formed about two years ago to exploit a wood distillation factory in Yugo-Slavia, and also the Suida patents, has now abandoned its original intention of also embarking upon the artificial silk industry in Yugo-Slavia. Instead the shareholders are to have more than half the capital returned to them in cash, while the wood distillation factory will go back to local ownership and the company will become more or less a holding company with interests therein. Under all the circumstances the shareholders are to be congratulated, and the relatively favorable outcome of this venture is recognized as having largely been due to the efforts and guidance of British chemical engineers.

The Magadi Soda Co., whose new chairman is Sir Harry McGowan, is meeting with difficulties on account of severe competition from Japan and India to its natural soda, and in consequence output has fallen from 72,000 tons in 1928 to 43,000 tons in 1930. The outlook is uncertain, in spite of reduction in the cost of manufacture, partly because of obligations to the Kenya government and partly on account of increased cost of railage and charges for oil fuel. At the annual meeting, Sir Harry McGowan made a very full disclosure of the position, and there is reasonable ground for thinking that the company will continue, but not on the large scale originally contemplated.

A very interesting paper was presented to a special chemical session organized by the Association of British Chemical Manufacturers, as part of the National Safety Week Congress. The paper was presented by J. Davidson Pratt, the general manager and secretary of the Association of British Chemical Manufacturers, which has been working for a long time through its works technical committee to evolve model safety rules for chemical factories and has issued very useful publications and some 50 safety circulars on the subject. Mr. Pratt's paper deals with the cleaning and repair of chemical plant, and in particular with the best safety rules in connection with vessels containing dangerous material.

Among the new vice-presidents of the Society of Chemical Industry, the name of J. Arthur Reavell, the retiring president of the Institution of Chemical Engineers, will be noted with particular pleasure. It is a well deserved honor and a slight token of the untiring work of Mr. Reavell on the council of the society and other bodies.

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N. Y. Rubber Division of A.C.S. Holds Spring Meeting

ON MAY 20, the New York group of the Rubber Division, American Chemical Society, held its final spring meeting. The program was featured by discussion of the subject of rubber in the telephone industry. A. R. Kemp, in charge of rubber and other organic research for the Bell Telephone Laboratories, gave an interesting illustrated account of the utilization of rubber in telephone apparatus. Applications include wire insulation, hard rubber parts of equipment, linemen's gloves, and rubber flooring.

The speaker described Paragutta, a compound of rubber and balata or gutta percha, which he and his associates developed for insulation of submarine telegraph cable. The new material is now being considered for a similar use on proposed submarine telephone cable.

Raw materials and compounding processes used in the industry were discussed, as well as the research work that has been done by the laboratories on the water absorption by various rubber compounds.

Dr. Kemp then explained in detail the compression tester which was developed for measuring that property of rubber covered wire. Results with the Geer oven test, the Bierer-Davis bomb, and others were described.

Members and guests, who numbered over 100, were also entertained by Roscoe M. Gace, chemist of the Fisk Rubber Co. and "Professor" Al Baker. The next meeting will be in October.

French Chemical Companies Made Favorable Showing Last Year

Kuhlmann Among Exceptions Which Reduced Rate of Dividends

From Our Paris Correspondent

GENERALLY speaking, the financial results of 1930 in the French chemical trade are better than it was feared, profits being substantial and in the majority of cases shareholders have received the same dividends as in 1929. Among the few exceptions is the Kuhlmann Co., with dividends reduced by 50 per cent, though the financial results of the 1930 expenditure are said to be better than those of the 1929 expenditure. The explanation given by the board of managers is that most of the financial bonds held by the company have dropped, because of the world crisis, and that the measure the board has reluctantly taken is a mere safeguard to prevent the company's treasury from any temporary embarrassment. It should be said that the Kuhlmann Co. has invested large sums of money in several minor chemical firms; rayon firms mainly. In spite of the reduced output of most of the rayon works and the heavy drop in sales prices, stocks have increased tremendously, with the result that a certain number of rayon works were compelled to reduce their output by 50 per cent and others even less favored had to close down altogether. Artificial wool works suffer particularly from the present crisis and there is no sign yet of better prospects in that branch.

As a rule the financial results of the rayon and artificial fiber works were far from brilliant in 1930 and generally no dividends were given to shareholders.

TO MAKE matters worse for the rayon industry the price of wool has dropped considerably, prices being even lower than prewar prices. The wool trade would regain most of its former prosperity, however, if the prices of the manufactured woolen articles were to drop to the same extent as the prices of the raw material. So far there is no sign of a fall in sales prices; on the contrary sales prices have increased and the cost of living has risen accordingly. Several attempts have been made to reduce salaries; namely, in the textile and mining industries, which are particularly handicapped by the present crisis, but these attempts were all failures. The result of the tariff world war gives the following results in France: the home price of cereals is three times greater than the world price, and the Danubian States wheat producers and buyers of French manufactured goods, have considerably reduced their orders, as they cannot sell their present stock of cereals.

The mutual damage done to all countries by the present world tariff war is considerable and in order to palliate to a certain extent the present crisis in Europe, a constructive plan, presented by the French delegation, is being now carefully examined by the League of Nations' Council. It is sincerely hoped that a more favorable result will be obtained this time, as former attempts made for the drawing in of international economical agreements were not successful.

The fertilizer industry has naturally been affected by the agricultural situation in 1930, and spring sales have not been as good as in 1929. It is hoped, however, that the autumn sales will make up for the difference.

The industrial depression in France has increased since the first of the year, though the number of unemployed is officially about fifty thousand. This figure is not accurate, as it gives only the number of unemployed officially assisted. In fact, all chemical workers work only 40 hours per week, instead of 48 as previously, and in some cases even less, as orders are not plentiful.

THE oil trade in France is controlled by the state, the controller being the National Office for Liquid Combustibles, which supplies its own budget by a tax of ½ per cent levied on all imported mineral oils. Nearly two million tons is imported yearly. A scientific research oil committee also exists in France and meets regularly. Its aims are to stimulate all researches in the boring of oil pits in France and colonial France; also in the extraction and refining of all mineral oils extracted; to make all necessary investigations and tests on synthetic petrols and substitutes. The National Office of Liquid Combustibles has thus created several research laboratories and also subventions the researches of various scholars on petroleum. A technical college, the Institute for Liquid Combustibles, also has been created by the National Office. This college is also supported by the Pechelbronn Oil Co., whose oil fields are in the close neighborhood of Strasbourg. In spite of governmental assistance up to now only 75,000 tons of oil has been extracted from French soil and this entirely from the Pechelbronn oil fields.

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Chemical Engineers to Tour England in 1932

MORE than 150 members of the American Institute of Chemical Engineers and their families have already indicated their intention to join the party that will tour England in June, 1932, according to a report made during the twenty-third semi-annual meeting at Swampscott, Mass., June 10-12 by A. E. Marshall, chairman of the committee of arrangements. It is planned to sail on the "Samaria," cabin steamer of the Cunard line, June 18, 1932, arriving in Liverpool, June 25. Sixteen days will be spent in the plant visits and inspection tours limited exclusively to institute members and their families. Raymond Whitcomb & Co., of New York City, which managed the tour of British chemical engineers in 1928, will make all arrangements and reservations.

The next semi-annual meeting of the institute will be held at Atlantic City, Dec. 9, 10, and 11, 1931. Plans for the technical sessions, which will include a symposium on stream pollution and trade waste disposal, will shortly be available from the office of the secretary, F. J. Le Maistre, Bellevue Court Building, Philadelphia, Pa.

Other important reports presented at the Swampscott meeting included a preliminary statement by Dr. Martin H. Ittner, chairman of the committee of nine which is studying certain proposed changes in the definition and classification of membership. The committee's proposal to include active, associate, and junior members will later be submitted to the membership for comment and criticism. Dr. H. C. Parmelee, chairman of the committee on chemical engineering education, announced that a formal statement of the procedure involved in the study of chemical engineering courses and instructional personnel will shortly be available. R. S. McBride, of Washington, is to serve as secretary of the committee, which is made up of representatives from the universities and from the chemical engineering industries.

At the annual banquet on June 11, Dr. John C. Olsen reviewed the early history and recent growth of the institute. Dr. Allan Winter Rowe, research director, Evans Memorial Hospital, gave a popular exposition of recent advances in glandular therapy, and Dr. Karl T. Compton, president of the Massachusetts Institute of Technology, spoke on "Science and the Future Civilization." He showed how the chemical engineer, through the prompt translation of science into new industries, can bring about a better balance of employment and a more satisfying use of leisure.

Prof. W. P. Ryan, of the Massachusetts Institute of Technology, and Francis J. Curtis, of the Merrimac Chemical Co., presided at the technical sessions, at which were presented the papers published in full or in abstract elsewhere in this issue. Prof. Carlos E. Harrington, of the University of Buffalo, served as chairman of the joint meeting of the newly formed process division of the American Society of Mechanical Engineers on June 12. Following that session both groups made an excursion to Gloucester, where the Birdseye quick-freezing process of the General Seafoods Co. was observed in operation. Other trips included visits to Lever Brothers and the laboratories of Arthur D. Little, Inc.

German Technical Activity Buoys Market Adversity

Large Concerns Issue Discouraging Reports Of Operations for 1930

From Our Berlin Correspondent

IN ITS annual report, the I. G. Farbenindustrie shows a retrogression for 1930 for the first time in many years. Nevertheless, three factors contributed to its resistance to the general depression: international agreement, progressive rationalization, and the access of new markets. The dividend is expected to remain 12 per cent, as in the three previous years, but the capitalization of the company has been reduced from 799,300,000 marks to 713,700,000, because the directorate decided to support its stock in cooperation with the banks. The universal tendency to increase local production, especially noticeable in the field of fixed nitrogen, resulted in a reduced consumption and consequently in curtailed operations and employment. In order to alleviate hardship, extraordinary expenses were incurred which influenced the annual report.

While the ailing child of the dye trust was rayon in the previous year, it was nitrogen this time. International agreements as well as the domestic organization prevented a collapse of the world's market, but fertilizer consumption in Germany itself for 1931 will not equal that in former years. Certain special products, such as urea and calcium ammonium nitrate, and especially the Nitrophoska group, have strengthened considerably. Production of nitrogen fertilizers was scaled down to decreased sales, so that stocks at the end of 1930 were practically equal to those in 1929. The international crisis is weighing particularly heavily on the textile industry, which naturally affected the sales of dyes and intermediates. On the whole, however, the dye industry is showing a good resistance. The principal dye exporting nations show a decrease of 10 per cent from 1929, the proportions remaining about the same, but the German fraction shows a slight increase. Friendly cooperation with Swiss and French competitors has alleviated the crisis, especially international competition in the Far East.

REGULATION of production and new markets helped to offset difficulties in inorganic products, organic intermediates, solvents, and light metals. New synthetic tanning materials and flotation chemicals of the I. G. have shown very satisfactory sales.

Pharmaceuticals, insecticides, and fine chemicals were also satisfactory in 1930. The recession in prices of rayon was counteracted by manufacturing economies and production of the high quality grade. The hydrogenation process also was developed further, but at present product prices commercial production is unthinkable. However, the I. G. has meanwhile made the arrangements with the Standard Oil of New Jersey which resulted in the International Hydrogenation Patents Co. The technical side of this development is represented by the International Hydrogenation Engineering & Chemical Co. at The Hague, Holland.

The personnel of the I. G. and subsidiaries totaled 114,197 workers and officials at the end of 1930. By means of shortened hours the dismissal of eight to nine thousand workers has been avoided. The American I. G. Chemical Corp., New York, shows a profit of about $3,969,000 for its second year of business. The net profit of $2,223,000 was used to raise the reserve (earned surplus) to about $4,411,000.

RUSSIAN dumping is making itself more strongly felt in the chemical industry, presumably because Russia feels that the prices on chemical products, which are fairly well fixed, are comparatively more profitable than in the case of Russia's main products—wood and petroleum. Consequently, there has been underbidding of the world market in caustic soda, sodium sulphide, acetic acid, and sodium acetate. On the other hand, such products as santonin, in which Russia has a monopoly, are being sold at many times the pre-war price. These price politics of Russia scarcely justify the opinion that Russian dumping is directed against "capitalistic price fixation." And Russian chemical exports can be expected to increase in the future.

In this connection it is reported that a factory is being erected at Jaroslaw for producing 5,000 tons of sugar annually from wood by the Bergius process. The inventor himself has just visited Moscow, where he is lecturing and consulting. Russian aluminum production also is being supported by outside consultants, such as director Julien of the French company, Alais Froges et Camargue.

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Fertilizer Trade Accepts New Trade Code

IN CONVENTION at White Sulphur Springs, W. Va., June 8-11, the National Fertilizer Association voted to accept the industry's trade practice rules as amended by the Federal Trade Commission, although little remains of the code originally approved by the commission in 1929. Manufacturers were outspoken in criticizing the extreme revision and Charles J. Brand, executive secretary, was instructed to advise the commission that the association regards the action taken without consulting the industry as arbitrary and improper. A concrete statement of what constitutes secret rebating in the fertilizer industry has been sacrificed in the commission's heavy-handed reversal of its previous policy of cooperating with industry in the elimination of unfair and uneconomic trade practices. The rebate rule is now reduced to language so general that it loses its force as a guide. The new code contains only three other rules. The sale of goods below cost with the intent and effect of injuring a competitor and defamation of competitors are declared to be unfair trade practices. The commission accepted as an expression of the trade a rule condemning the withholding from or insertion in invoices of statements that make such invoices a false record.

In considering the technical aspects of its program, the convention instructed its officers to promote the previously approved plan to make the order in describing the constituents of fertilizers read NPK instead of PNK.

The convention also authorized elimination of the expression of nitrogen content in terms of ammonia equivalent, confining it to an expression in terms of nitrogen as such. The convention approved the proposal, discussed in May at a meeting in New York with state officials, that analyses should be stated in full units and not in fractions or decimals. Action will be sought in various states to bring about measures for fixing the minimum of plant food content at 16 per cent. Fertilizers containing less than this amount are regarded as uneconomic because the use of inert fillers is almost inevitable. The Department of Agriculture demonstrated a method of supplying superphosphate with nitrogen by direct ammoniation with anhydrous ammonia.

Because of the unfavorable out-turn of the season, the tonnage of fertilizer consumed in 1931 will average 25 per cent less than in 1930. Consumption in the Southwest is reported to be 53 per cent off. As a result the work of the association will be curtailed. Although unavoidable, this is regrettable, said Mr. Brand, because the sales promotion campaign must be discontinued. In addition to loss of income, the association's membership dues have been greatly reduced.

Bayless W. Haynes, president of the Wilson & Toomer Fertilizer Co., Jacksonville, Fla., was elected president of the association. John J. Watson, president of the International Agricultural Corporation, New York City, was elected vice-president, and Charles J. Brand, was reelected executive secretary and treasurer. New members of the board of directors are W. L. Waring, Jr., Lyons Fertilizer Co., Tampa, Fla.; E. L. Robins, president of the Meridian (Miss.) Fertilizer Works; S. J. Martenet, E. Rauh & Sons Fertilizer Co., Indianapolis; and John J. Watson.

MEN
IN CHEMICAL ENGINEERING

J. M. WADSWORTH has joined the Foster Wheeler Corp. as consulting engineer with its oil division. Mr. Wadsworth has been constantly active in oil refining work ever since his graduation from Stanford University in 1910. After several years of engineering with refineries in California, he joined the U. S. Bureau of Mines as refinery engineer and conducted his investigations in various parts of the country. In 1916, he joined the Empire Gas & Fuel Co. in charge of refining and carried out an expansion program for three years. Another five years was spent

with the Pierce Petroleum Corp., after which he joined the Independent Oil & Gas Co. He became director and vice-president of this company in 1930 and its general superintendent of refineries after it merged with the Phillips Petroleum Co.

ARTHUR D. LITTLE, president of Arthur D. Little, Inc., received the degree of Doctor of Science at Columbia University on June 2, for "covering in his field of influence and interest almost every aspect of chemical engineering practice" and as one who "pursues science with true dignity."

DAVID J. PRICE, of the Bureau of Chemistry and Soils, U. S. Department of Agriculture, received the honorary degree of Doctor of Philosophy from American University, June 1, in recognition of his work on causes and control of dust explosions.

CHARLES BELKNAP, president of Merrimac Chemical Co., Everett, Mass., has been elected executive vice-president of the Monsanto Chemical Works, the parent company.

FREDERICK M. FEIKER, who has been managing director of the Associated Business Papers, Inc., since 1927, was appointed director of the Bureau of Foreign and Domestic Commerce, Department of Commerce, by President Hoover, to succeed William L. Cooper, who has returned to the London office. Mr. Feiker's career includes eight years of service with the McGraw-Hill Publishing Co. as editor and executive, during which his services were borrowed by the Department of Commerce for various organization work. Mr. Feiker's new appointment represents special emphasis on the problems of domestic commerce.

DONALD E. CABLE has been transferred from the Cleveland plant of the U. S. Rubber Co. to the general laboratories at Passaic for the development of new products.

GEORGE C. LEWIS, president of the Darco Sales Co. and general manager and vice-president of L. Martin Co., has been installed as president of the Chemists' Club, New York City. A native of India, Mr. Lewis was educated in England, and after a rather adventurous career as a British naval officer, came to this country. Here he has been identified especially with the technology of carbon, meanwhile participating actively in the affairs of the Chemists' Club.

W. F. FARAGHER, since 1926 director of the research laboratory at the Universal Oil Products Co., has joined the research staff of the Vacuum Oil Co. at Paulsboro, N. J. Dr. Faragher began his career as an instructor of chemistry in Kansas, his native state, in 1905, and engaged in industrial research until 1918, when he joined the Mellon Institute. He was assistant director there from 1923 to 1926 and meanwhile headed the petroleum department in the University of Pittsburgh.

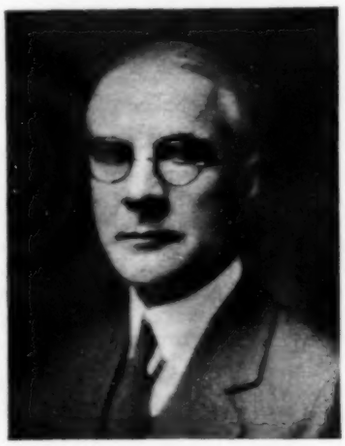
WILLIAM M. RAND, vice-president of Merrimac Chemical Co., has been elected a director of Monsanto Chemical Works, St. Louis, Mo.

ALFRED FISHER, who was consulting engineer in New York, has joined the staff of the Universal Oil Products Co. in Chicago for research and development work. Mr. Fisher is a graduate of the University of London and during the War was employed by the British government for chemical warfare development. While a consultant in the past five years in New York City he has specialized on coal and gas.

H. M. LAWRENCE, who was with the International Agricultural Corp., has been appointed to the staff of the American Standards Association in charge of mining, chemical, and metallurgical projects. Mr. Lawrence has been connected with the U. S. Bureau of Mines, Portland Cement Association, and the Johns-Manville Corp.

HAROLD J. PAYNE, formerly on the editorial staff of *Chem. & Met.*, and for the past year assistant managing director of the Associated Business Papers, Inc., has now been appointed secretary.

SALMON WILLOUGHBY WILDER retired June 4 as chairman of the executive committee of the Manufacturing Chemists' Association, in which he has been a member for thirty years. Since 1920 he served on the executive committee and became its chairman in 1925. In a ceremony at the conclusion of the annual banquet of the association, Dr. Charles L. Reese presented Mr. Wilder with a handsomely bound volume of let-



ters from his many friends in chemical industry. After being graduated from Massachusetts Institute of Technology in 1891 Mr. Wilder worked as a chemist for several New England paper companies. Then he joined the Merrimac Chemical Co. in 1898, became its treasurer in 1902, president in 1905, and chairman of the board in 1928.

JAMES A. LEE, assistant editor of *Chem. & Met.*, has been engaged in a several weeks' tour of parts unknown, subsequent to his marriage on June 6 at Bel Air, Md.

A. S. RICHARDSON, of Procter & Gamble Co., Cincinnati, was elected president of the American Oil Chemists Society at its meeting in New Orleans.

R. C. HOLMES, president of the Texas Corp., has resigned as vice-president for refining and chairman of the general committee of the American Petroleum Institute's division of refining.

FRANK H. RIDDLE, director of research of the Champion Porcelain Co.,

received the degree of Professional Ceramic Engineer from Ohio State University in recognition of his research in various fields of ceramics.

L. D. Vorce, consulting engineer for Westvaco Chlorine Products, Inc., and designer of the Vorce cell, received the degree of Doctor of Engineering from the Case School of Applied Science, where he graduated in 1889.

OBITUARY

John W. Daniels, chairman of the board and one of the founders of the Archer-Daniels Midland Co., of Minneapolis, Minn., died on June 8, after a month's illness. Mr. Daniels was born on Feb. 23, 1857, at Piqua, Ohio, and started work in a Piqua linseed-oil factory. Later he became associated with the American Linseed Co., and in 1902 he moved to Minneapolis to build a mill that was nearer to the source of flax production. His first company was the Daniels Linseed Co., which a year later became the Archer-Daniels Co.

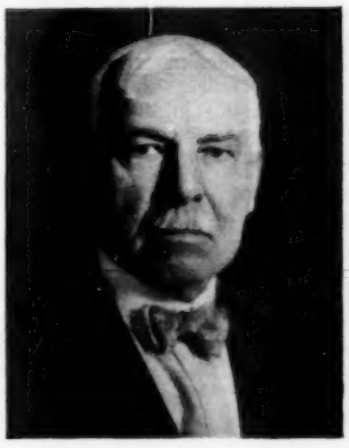
Samuel Wilson Parr, professor emeritus of applied chemistry at the University of Illinois, died of heart failure at his home in Urbana, Ill., on May 16, at the age of 74, after three months of illness, from which he apparently was recovering. He had grown steadily stronger, was occupied in the revision of his book, and had finished writing a convention paper only an hour before his death.

Although Prof. Parr's name was widely known for a number of technical achievements, he was even more influential through his many years of contact at the University of Illinois. Prof. Parr was born in Granville, Ill., in 1857, graduated from the University of Illinois in 1894, and later completed his studies at Cornell, Berlin, and Zurich. After beginning his career at Illinois College in 1895, he became professor of applied chemistry at the university and held this position until his retirement in 1926. Meanwhile he also was actively connected with the Illinois State Water Survey and State Geological Survey. The Parr calorimeter, and its modifications, was perhaps his leading achievement. The alloy "Illium," used particularly in connection with calorimeters, was another of his better-known inventions. As an authority on fuel and coal technology, he not only wrote several leading books but was also called into consultation for the National Fuel Survey in 1924. In 1926, the Chandler Medal was awarded to him; in 1928 he was president of the American Chemical Society.

The influence of his teaching could best be told in the words of one of his former students:

Professor S. W. Parr, beloved teacher, counsellor, and friend, has passed on to his reward, which will continue to reach him through knowledge of the affectionate regard and unfailing honor borne him by all his students and associates. I have been one of them for 33 years, and never have known of any unkindness or unfairness on his part toward anyone. Such a record surely does great honor to any man, and Parr, besides, added his outstanding achievements in teaching and in contributions to the store of human knowledge.

As one who has followed closely his researches in the chemistry of coal and in coal carbonization, I may perhaps be permitted to say that I know this work has been pioneering, original and of lasting value. His well-known coking process, for example, in two stages, especially devised for the weakly coking, high-oxygen type of coal found in Illinois, is based on investigations of the composition and behavior of this type that are the most thorough and fundamental ever made. The process may have practical working difficulties that will hold it back commercially for a time, but the fundamental principles that



have been worked out in it will live and come some day to practical fruition.

This, after all, in the thing of greatest importance, and for such achievements we owe greatest homage.

Horace C. Porter.

J. George Lehman, president of the Bethlehem Foundry & Machine Co., ended his life with a bullet on the morning of May 14 at his home in Bethlehem. No probable cause for the act has yet been educed. Mr. Lehman was a graduate of Lehigh University with the class of 1896.

E. W. Clark, chairman of the board of directors of the Union Oil Co., died May 12 in Los Angeles of a heart attack, at the age of 73. Mr. Clark first engaged in the oil industry in 1914, becoming vice-president of the Union Oil Co. He was general manager of the company in 1916, until he resigned, while continuing as director, in 1929. He was elected chairman of the board in 1930 and in March of this year was elected president of the Union Oil Associates. He was one of the organizers of the American Petroleum Institute and later served as it president for two terms, in 1927 and 1928.

Frank Wigglesworth Clarke, internationally known authority on atomic weights, mineral analyses, and the classification of minerals and rocks, died at his home in Washington, D. C., May 23, at the age of 85. Dr. Clarke had been chief chemist of the U. S. Geological Survey from 1883 to 1925, when he retired. He was a past president of the American Chemical Society and a member of the National Academy of Sciences.

André Michelin, the pioneer French tire manufacturer, of Clermont-Ferrand, in Auvergne, died recently in Paris at the age of 76. As leading rubber magnate of France he successfully invaded numerous markets for his products the world over. Well known as a philanthropist for his social works for infants and invalids, he was the promoter in France of higher wages for all workmen having large families.

CALENDAR

American Institute of Chemical Engineers, Atlantic City, N. J., Dec. 9-11.

American Chemical Society, 82d meeting, Buffalo, N. Y., Aug. 31-Sept. 4.

American Society for Testing Materials, Chicago, June 22-26.

Electrochemical Society, fall meeting, Salt Lake City, Utah, Sept. 2-5.

Third International Conference on Bituminous Coal, Pittsburgh, Nov. 16-21.

German Technical Sessions

VIENNA was chosen by three prominent German technical societies as spring meeting place, the dates being arranged to permit a consecutive week of sessions lasting from May 25 to 30. The Deutsche Bunsen-Gesellschaft (for applied physical chemistry) met first and was followed by the Deutsche Gesellschaft für Chemisches Apparatewesen in conjunction with the Verein Deutschuer Chemiker. Because a number of papers were of particular interest for chemical engineers, a fuller report will appear in *Chem. & Met.* for July.

At the Bunsen-Gesellschaft, F. Skaupy spoke on "Behavior of Metal Powders Under Pressure"; A. Koenig on "Chromium Plating of Light Metals"; M. Centnerszwer on "Resistance of Purest Aluminum to Acids and Bases"; W. Schmidt on "Technology of Elektron"; and H. Paweck on "Progress in Alkali-Chlorine Electrolysis."

The Dechema sessions were devoted to the topic of mechanical separation. Filtration was represented by papers on glass filters, porous rubber filters, the metafilter, ultrafiltration, rotary vacuum filters, and a comparison with decantation. Spraying and crystallization, wet and dry classifying, flotation, rectification, and silica adsorption were the subjects of the remaining papers.

ECONOMIC INFLUENCES

on production and consumption of CHEMICALS

Distribution of Chemicals Showed Gain in Second Quarter

Returns to Producers Reported More Favorable In March-June Period

WHILE improvement in the tonnage movement of chemicals was not general throughout the second quarter of the year, the gains reported in different divisions of the industry were regarded as more than an offset to the losses incurred in other branches. Hence the total movement for the second quarter is expected to show up in the final figures as registering a gain over the total for the first three months. In some cases activities in June were on a higher scale than those for May, as demonstrated by the announcement that one large producer would operate in June at 80 per cent of capacity, against 76 per cent in May. The same company reported June employment at 31 per cent higher than on Feb. 1. The seasonally adjusted index of factory production computed by the Federal Reserve Board, reflecting the combined output of the leading manufactured products in April, showed the fourth consecutive monthly gain, with a total advance of 11 per cent from the low level of midwinter.

This expansion of factory output is not attributable to the iron and steel, construction, and heavy equipment industries, which have continued at low ebb, but to improvement in industries producing finished goods for consumption, notably food products, textiles, leather and shoes, and automobiles.

THE cotton textile industry, particularly, has maintained its recent strength, with mill consumption of raw cotton in April the largest in a year and stocks of cotton goods reduced by 36 per cent from the level of a year ago.

Consumption of raw silk, as indicated by mill takings, increased during May, the total being 45,073 bales, as compared with 41,356 bales in April. The average monthly consumption for the first five months of this year was 50,393 bales, against 48,161 bales during the corresponding period of 1930.

Consumption of paint and varnish materials has responded to seasonal conditions. The output of dry ice is progressing steadily and it is estimated that the 1931 production will approximate 85,000,000 lb. In 1925 total production was reported at 270,000 lb. The widespread increase in the use of safety glass is broadening the demand for pyroxylin plastics, and the potential field for plastics in the glass industry is estimated at a very high figure.

LATEST official statistics available relative to production and consumption in different branches of the chemical industry are for April. The following figures give some comparisons of activities for April in 1931 and 1930:

	April 1931	April 1930
Production		
Arsenic, crude, ton	1,402	1,350
refined, ton	964	1,084
Automobiles—		
Cars, No.	285,028	372,446
Trucks, No.	50,015	71,092
Taxis, No.	665	486
Byproduct coke, 1,000 tons	3,146	4,246
Ethyl alcohol, withdrawn for denaturing 1,000 gal.	10,541	10,585
Lime, acetate, 1,000 lb.	4,517	8,101
Methanol, crude, gal.	325,794	518,039
refined, gal.	211,073	524,295
Petroleum refined, 1,000 bbl.	74,706	80,434
Plate glass, 1,000 sq.ft.	10,174	11,430
Turpentine, wood, bbl.	6,344	8,303
Rosin, wood, bbl.	35,585	43,919
Pine oil, gal.	219,053	253,049
Consumption		
Cotton, bales	508,744	531,911
Silk, bales	41,356	41,584
Wool, 1,000 lb.	47,710	36,794
Rubber, tons	33,321	40,207
Sulphuric acid in fertilizers, ton	107,789	201,993
Fertilizer in Southern states, ton	1,132	1,280

In the above tabulation the production figures for methanol refer only to the output of the wood distillation branch of the industry. Production of synthetic methanol increased to 785,164 gal. in April, making the January-April production 2,949,685 gal., compared with 2,080,618 gal. for the corresponding period of 1930. Sales of paint, varnish, and lacquer products have shown an increasing trend since the first of the year. Reports from 588 manufacturers place total sales in April at $32,371,463, compared with $26,673,666 for March and $38,481,677 for April, 1930.

Fertilizer sales have failed to make up for the losses incurred in the earlier part of the fertilizer season and tag sales for sixteen states for December-May inclusive were 3,847,624 short tons, as compared with 5,336,947 short tons for the corresponding period of the preceding season. It is evident, therefore, that the fertilizer industry cannot hope to make a favorable showing this year.

FOREIGN trade prospects, both imports and exports, likewise do not appear to be favorable. While our tariff act may be responsible to some extent for the falling off in export trade, foreign competition and reduced consuming requirements abroad offer the most reasonable explanation for the decline in shipments from this country.

Exports of chemicals and related products for the four months ended April 30 were valued at $37,167,738, compared with $47,448,757 for the comparable period of 1930. This represents a drop of more than 21 per cent in value but lower price levels would reduce somewhat the decline in volume. Among the industrial chemical group, aluminum sulphate, calcium chloride, copper sulphate, and niter cake stand out as exceptions, with larger amounts exported than a year ago. Exports of sodas fell off more than 14 per cent in volume, with caustic soda alone reporting a gain.

Imports of chemicals for the same period were valued at $35,459,945, against $51,509,745 in 1930, hence the decline in imports was larger than that for exports. Material decreases were noted in imports of potash salts, nitrate of soda, and other fertilizer materials. Acetic acid also showed a marked decline in shipments from Canadian ports.

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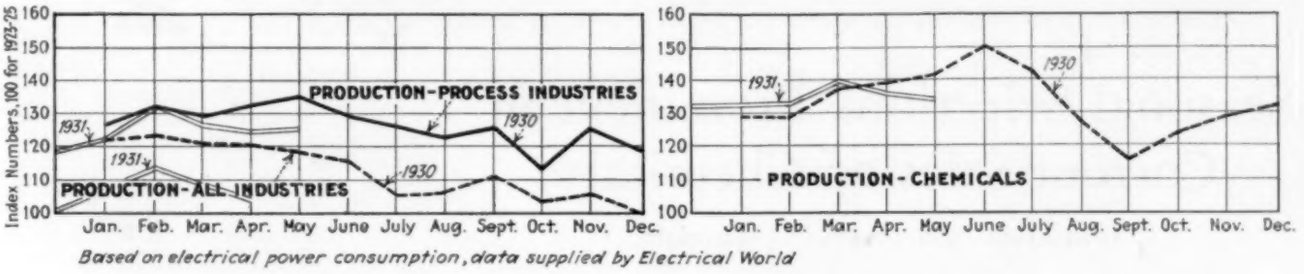
Production in Coal-Tar Crudes in 1930

THE Tariff Commission has issued the following preliminary table showing the total production, by quantity and value, of certain coal-tar crudes in 1930. These data are collected jointly with the U. S. Bureau of Mines. Firms not primarily engaged in the operation of coke-oven plants and gas houses report to the Tariff Commission; all others report to the Bureau of Mines.

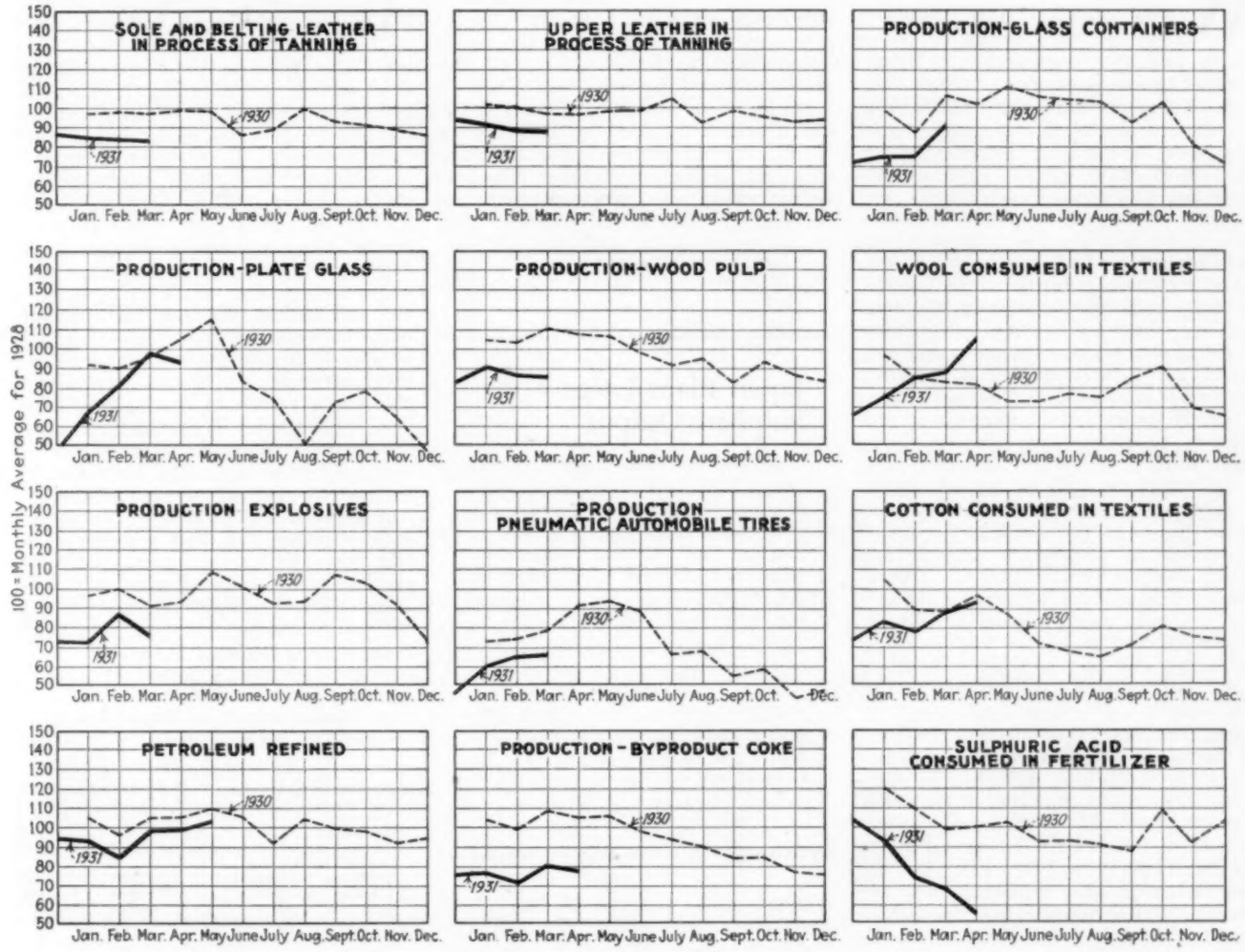
	Quantity	Value
Coal tar, gal.	647,485,929	.....
Tar distilled, [1] gal.	362,183,422	.....
Benzene (benzol), gal.	19,918,059	$3,544,929
Motor benzol, gal.	104,036,569	14,674,441
Dead or creosote oil, [2] gal.	128,788,528	13,978,238
Naphthalene, lb.	31,675,696	466,838
Solvent naphtha, gal.	6,698,623	1,288,150
Refined tars, bbl.	2,565,292	11,293,996
Pitch of tar, tons	607,727	.....

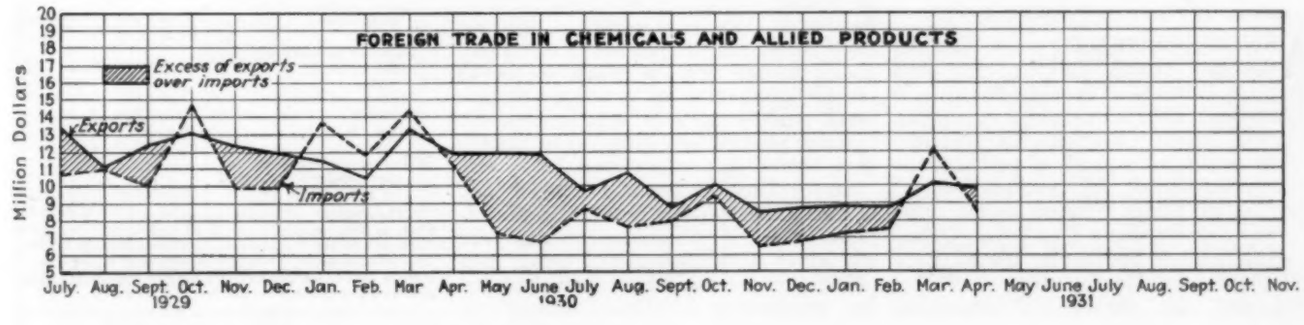
[1] By firms engaged primarily in the distillation of tar.
[2] Includes creosote oil distilled as such, and distillate in coal-tar solution.

ACTIVITY IN PRODUCING AND CONSUMING INDUSTRIES



Based on electrical power consumption, data supplied by Electrical World




FOREIGN TRADE IN CHEMICALS AND ALLIED PRODUCTS
Million Dollars
Excess of exports over imports
Exports
Imports
July Aug. Sept. Oct. Nov. Dec. Jan. Feb. Mar Apr. May June July Aug. Sept. Oct. Nov. Dec. Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov.
1929
1930
1931

MARKET CONDITIONS —AND PRICE TRENDS

Seasonal Selections Prominent in Current Sales of Chemicals

Agricultural and Insecticide Materials Move in Good Volume

WITHDRAWALS against running contracts have shown a tendency to slow up in recent weeks and spot trading has not been marked by any particular activity. Seasonal influences have increased demand for certain chemicals and good interest has been reported for copper sulphate, calcium arsenate, calcium chloride, lead arsenate, chlorate of soda, citric and tartaric acids. Consumption of chemicals in the textile industry likewise has held up well and other consuming lines have been taking fairly normal quotas, so that, generally considered, the total tonnage movement has been satisfactory.

Pigments, colors, oils, and other materials which enter into the manufacture of paints, varnishes, and lacquers found a steady outlet and in some cases productive activities were speeded up to meet the larger demand experienced.

In connection with the outlook for export trade, considerable interest has been shown in the changes in import duties as established in Canada and provisionally effective June 2. Apparently the items affected by the changes will not have much bearing on sales of chemicals to Canada, as the selections on which our largest tonnage is based are not subject to higher tariffs. Incidentally our consul at Windsor reports that the Canadian Salt Division of the Canadian Industries is now manufacturing anhydrous ammonia in sufficient quantities to take care of the entire Canadian demand. The actual production of this chemical was started at the Sandwich plant in June, 1930, but the announcement was withheld until the success of the venture had been thoroughly demonstrated. The Casale process is employed under exclusive Canadian rights purchased by Canadian Industries.

ANNOUNCEMENTS made during the last month indicate that the chemical industry is looking for future expansion. This is evidenced in reports that the Niacet Chemicals Corporation is now producing a grade of paraldehyde conforming to all the requirements of the United States Pharmacopœia; the Texaco Salt Products Co., Tulsa, Okla., is about ready to operate its new $2,000,000 plant (the Martin process will be used and the output will comprise sodium products, salt, and calcium chloride); the Jefferson Lake Oil Co. has purchased part of the plant of the Union Sulphur Co., at Sulphur, La., and will work sulphur deposits discovered in Lake Peigñeur; the Dow Chemical Co. will establish a plant at Wilmington, N. C., for the extraction of bromine from sea water (the Ethyl Gasoline Corp., which uses large quantities of ethylene dibromide in making antiknock motor fuels, will join in this enterprise); on June 1 the Monsanto Chemical Works reopened its chamber sulphuric-acid unit which had been closed for six months; the Diamond Match Co. plans to erect a new plant to produce chemicals, notably chlorate of potash. There is no domestic production of chlorate of potash at present; the Woodbridge Alcohol Co., Lodi, Calif., is altering its plant so as to include production of cream of tartar; press reports credit a new process for making plastics in which sugar figures prominently as a raw material.

In the May number of *Chem. & Met.* it was estimated that production of sulphur in the first quarter of the year was close to 650,000 tons. Since then official figures have been issued showing production in Texas during the first quarter of 1931 amounted to 649,594 gross tons, according to report of the State Comptroller. Of this amount, Texas Gulf Sulphur Co. produced 234,105 tons and Duval Texas Co. 11,805 tons. Production is 28,525 tons below the final 1930 quarter, when Texas Gulf produced 455,584 tons; Freeport, 211,825; and Duval Texas, 10,710 tons.

AMONG developments in foreign markets prominence has been given to the long drawn-out conferences held for the purpose of renewing the agreement among world producers of nitrogen. The conferences began about the middle of April, but evidently have not been successful, as no definite reports of progress have been made public. Recent reports indicate that dissension has arisen which may result in some of the large producing nations withdrawing from the negotiation. The present agreement will expire on June 30, and unless the ten participating countries agree on export quotas, which is said to be the main obstacle before the conference, the chances are favorable for a return to open competition.

A cable to the Department of Commerce states that the May export of tung oil has been greatly stimulated by an upward revision of the Chinese export duty on that product. The export duty, effective June 1, is reported to be 1.58 Haikwan taels per picul, while the previous duty assessed was only 0.30 Haikwan tael per picul. In view of the active market, Hankow stocks are being rapidly depleted.

Japan Plans Large Sulphate Output

According to estimates of the Japan Fertilizer Association, production of sulphate of ammonia in that country will reach a total of 666,000 tons in 1932. Consumption for that year is estimated at 670,000 tons, so the home output will practically take care of all requirements. Production will come from fifteen companies with a small contribution from government works. The largest producer will have an estimated output of 250,000 tons. In the present year Japan is expected to import close to 150,000 tons.

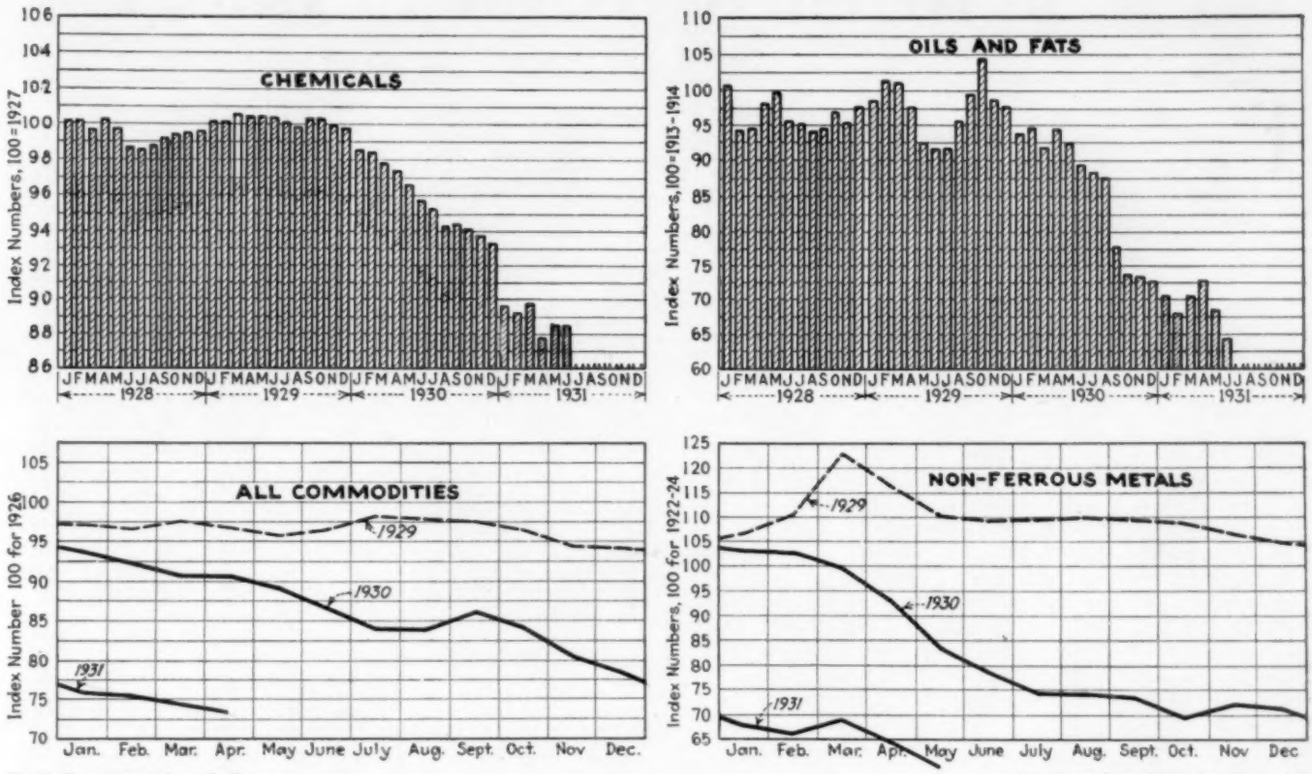
Census Report on Production Of Insecticides

	1929	1927
Disinfectants, total value	$7,331,787	$6,088,781
Coal-tar, lb.	21,773,790	25,230,545
Value	$4,637,106	$3,824,974
Pine oil, lb.	1,831,653	2,897,009
Value	$426,784	$442,072
Chloride of lime and chlorine products, lb.	2,835,904	1,390,607
Value	$536,424	$123,925
Other, lb.	11,280,930	7,283,512
Value	$1,731,383	$1,697,810
Household insecticides, total value	$15,077,107	(1)
Spray, fly, lb.	36,685,374	[2]18,407,817
Value	$9,322,578	[2]$6,100,798
Insect powder (Pyrethrum), lb.	5,542,498	[2]2,730,863
Value	$2,446,524	[2]$1,772,153
Fluoride powders and mixtures, lb.	700,845	614,878
Value	$385,199	$310,236
Moth repellents, lb.	2,364,401	3,679,903
Value	$799,774	$1,103,685
Other, lb.	8,954,579	14,197,294
Value	$2,123,032	$3,621,105
Disinfectants and household insecticides not reported by kind, value	$3,345,314	.....

[1] The Bureau of the Census attempted, for the first time, at the census for 1927 to collect detailed data in regard to the production of household insecticides. The returns were, however, incomplete in respect of certain items, particularly fly sprays and insect powder, and therefore no total for 1927 is given.

[2] Incomplete; see footnote 1.

CHEM. & MET. *Weighted Indexes of* PRICES



U. S. Department of Labor — *Engineering & Mining Journal*

Chemical Prices Show Tendency To Hold Present Levels

WHILE the weighted index number for chemicals was slightly lowered last month, the majority of offerings showed a tendency to maintain former levels and only minor changes in either direction are anticipated for the near future. The summer months, with a slowing up in industrial activities, usually brings out soft spots in the market, but prices have declined to such an extent that an exception may be found this summer.

The future price position of sulphur appears to arouse more discussion than is noted for other commodities. This was heightened during the month by the report that a new producer was preparing to enter the field. However, tentative plans for new production do not contemplate an output large enough to disturb the market. On the other hand financial returns to producers have declined this year and Texas has increased its production tax from 55c. to 75c. a ton, thus adding to the overhead of producers. In addition, sharp increases in assessed values will add materially to the property taxes of the companies operating in Texas. In other words, the cost of producing sulphur has been increased, and under such conditions competition from outside the industry would appear to be the only factor on which hopes for lower prices might be based.

Alkalis, chlorine, and alcohol have passed through drastic price-cutting periods which had the salutary result of proving that price wars were disastrous to industry. Wood distillers adversely affected by competitive conditions and by the loss of the denaturant market for methanol have met the situation by reducing outputs, but prospects are now brighter for the restoration, at least in part, of methanol in the denaturing field.

Crop prospects are looming up as factors in the market for vegetable oils with especial reference to linseed oil and cotton-seed oil. In the case of linseed oil the prospects favor a 10 per cent reduction in acreage sown to flaxseed in the American Northwest. In the long run this should have a bullish effect on the market, but for the present but little change from existing prices is expected.

The growing cotton crop is of interest because the amount of seed available and the volume of early season marketing will have much to do with directing the price for crude oil, which in turn has a marked influence on the price structure of the entire vegetable oil market. With the exception of China wood oil, on which a higher export tax has been established, the position of foreign-produced oils has not changed for the better.

Chem. & Met. Weighted Index of Chemical Prices

Base = 100 for 1927

This month	**88.49**
Last month	88.62
June, 1930	95.87
June, 1929	100.25

Spirits of turpentine again held a slightly higher average for the month, but ethyl acetate, benzol, and other chemicals were lower, and the weighted index number declined. Copper sulphate made a new low price record during the period.

Chem. & Met. Weighted Index of Prices for Oils and Fats

Base = 100 for 1927

This month	**64.39**
Last month	68.29
June, 1930	89.23
June, 1929	91.57

Lower prices were again almost general, and this held true not only for oils but also for fats and glycerine. China wood oil held fairly steady and higher export duties in China may strengthen the market later on.

CURRENT PRICES *in the* NEW YORK MARKET

THE following prices refer to round lots in the New York market. Where it is the trade custom to sell f.o.b. works, quotations are given on that basis and are so designated. Prices are corrected to June 13.

Industrial Chemicals

	Current Price	Last Month	Last Year
Acetone, drums, lb.	$0.10 -$0.11	$0.10 -$0.11	$0.11 -$0.12
Acid, acetic, 28%, bbl., cwt.	2.60 - 2.85	2.60 - 2.85	3.88 - 4.03
Glacial 99%, tanks	8.98 -	8.98 -	-
drs.	9.23 - 9.48	9.23 - 9.48	-
U. S. P. reagent, c'bys.	9.73 - 9.98	9.73 - 9.98	-
Boric, bbl, lb.	.06½- .07	.06½- .07	.06½- .07
Citric, kegs, lb.	.36 - .37	.37 - .38	.46 - .47
Formic, bbl, lb.	.10 - .11	.10 - .11	.10½- .11
Gallic, tech., bbl., lb.	.50 - .55	.50 - .55	.50 - .55
Hydrofluoric 30% carb, lb.	.06 - .07	.06 - .07	.06 - .07
Latic, 44%, tech., light, bbl, lb.	.11½- .12	.11½- .12	.11½- .12
22%, tech., light, bbl., lb.	.05½- .06	.05½- .06	.05½- .06
Muriatic, 18°, tanks, cwt.	1.00 - 1.10½	1.00 - 1.10	1.00 - 1.10
Nitric, 36°, carboys, lb.	.05 - .05½	.05 - .05½	.05 - .05½
Oleum, tanks, wks., ton	18.50 -20.00	18.50 -	18.50- 20.00
Oxalic, crystals, bbl., lb.	.11 - .11½	.11 - .11½	.11 - .12
Phosphoric, tech., c'bys., lb.	.08½- .09	.08½- .09	.08½- .09
Sulphuric, 60°, tanks, ton	11.00 -11.50	11.00 -11.50	11.00 -11.50
Tannic, tech., bbl., lb.	.23 - .35	.23 - .35	.35 - .40
Tartaric, powd., bbl., lb.	.30½- .33	.30½- .33	.36 - .38
Tungstic, bbl., lb.	1.40 - 1.50	1.40 - 1.50	1.40 - 1.50
Alcohol, ethyl, 190 p'f., bbl., gal.	2.33 -	2.33 -	2.63 - 2.71
Alcohol, Butyl, tanks, lb.	.15½-	.15½-	.16½- .17
Alcohol, Amyl	-	-	-
From Pentane, tanks, lb.	.236-	.236-	- .236
Denatured, 188 proof			
No. 1 special dr., gal.	.27 -	.27 -	.42 -
No. 5, 188 proof, dr., gal.	.27 -	.27 -	.42 -
Alum, ammonia, lump, bbl., lb.	.03½- .04	.03½- .04	.03½- .04
Chrome, bbl., lb.	.04½- .05	.04½- .05	.05½- .06
Potash, lump, bbl., lb.	.03½- .04	.03½- .04	.03 - .03½
Aluminum sulphate, com., bags, cwt.	1.25 - 1.40	1.25 - 1.40	1.40 - 1.45
Iron free, bg., cwt.	1.90 - 2.00	1.90 - 2.00	1.90 - 2.00
Aqua ammonia, 26°, drums lb	.02½- .03	.02½- .03	.03 - .04
tanks, lb.	.02½- .02½	.02½- .02½	-
Ammonia, anhydrous, cyl., lb.	.15½- .15½	.15½- .15½	.15½ -
tanks, lb.	.05½-	.05½-	-
Ammonium carbonate, powd. tech., casks, lb.	.10½- .11	.10½- .11	.10½- .11
Sulphate, wks., cwt.	1.75 -	1.75 -	2.00 -
Amylacetate tech., tanks, lb., gal	.164-	.164-	.222-
Antimony Oxide, bbl., lb.	.08½- .10	.08½- .10	.09 - .10
Arsenic, white, powd., bbl., lb.	.04 - .04½	.04 - .04½	.04 - .04½
Red, powd., kegs, lb.	.09 - .10	.09 - .10	.09 - .10
Barium carbonate, bbl., ton	58.00 -60.00	58.00 -60.00	58.00 -60.00
Chloride, bbl., ton	63.00 -65.00	63.00 -65.00	64.00 -70.00
Nitrate, cask, lb.	.07 - .07½	.07 - .07½	.07 - .07½
Blanc fixe, dry, bbl., lb.	.03½- .04	.03½- .04	.03½- .04
Bleaching powder, f.o.b., wks., drums, cwt.	2.00 - 2.10	2.00 - 2.10	2.00 - 2.10
Borax, bbl., lb.	.033-	.033-	.033-
Bromine, cs., lb.	.36 - .38	.36 - .38	.45 - .47
Calcium acetate, bags	2.00 -	2.00 -	4.50 -
Arsenate, dr., lb.	.06 - .07	.06 - .07	.07 - .08
Carbide drums, lb.	.05 - .06	.05 - .06	.05 - .06
Chloride, fused, dr., wks., ton	20.00 -	20.00 -	20.00 -
flake, dr., wks., ton	22.75 -	22.75 -	22.75 -
Phosphate, bbl., lb.	.08 - .08½	.08 - .08½	.08 - .08½
Carbon bisulphide, drums, lb.	.05 - .06	.05 - .06	.05 - .06
Tetrachloride drums, lb.	.06½- .07	.06½- .07	.06 - .07
Chlorine, liquid, tanks, wks., lb.	.01½-	.01½	.02½
Cylinders	.04 - .06	.04 - .06	.04½- .06
Cobalt oxide, cans, lb.	1.75 - 1.85	1.75 - 1.85	2.10 - 2.25
Copperas, bgs., f.o.b. wks., ton	13.00 -14.00	13.00 -14.00	13.00 -14.00
Copper carbonate, bbl., lb.	.08½- .18	.08½- .17	.13 - .20
Cyanide, tech., bbl., lb.	.41 - .46	.41 - .46	.45 - .46
Sulphate, bbl., cwt.	3.70 - 4.00	4.25 - 4.50	4.75 - 5.00
Cream of tartar, bbl., lb.	.23½- .24	.23½- .24	.26½- .27
Diethylene glycol, dr., lb.	.14 - .16	.14 - .16	.11 - .13
Epsom salt, dom., tech., bbl., cwt.	1.70 - 2.00	1.70 - 2.00	1.75 - 2.00
Imp., tech., bags, cwt.	1.15 - 1.25	1.15 - 1.25	1.15 - 1.25
Ethyl acetate, drums, lb.	.07 -	.08 -	.121-
Formaldehyde, 40%, bbl., lb.	.06 - .07	.06 - .07	.07½- .08
Furfural, dr., contract, lb.	.10 - .12	.10 - .12	.10 - .12
Fusel oil, crude, drums, gal.	1.10 - 1.20	1.30 - 1.40	1.30 - 1.40
Refined, dr., gal.	1.80 - 1.90	1.90 - 2.00	1.90 - 2.00
Glaubers salt, bags, cwt.	1.00 - 1.10	1.10 - 1.20	1.00 - 1.10
Glycerine, c.p., drums, extra., lb.	.12 - .12½	.12½- .13	.14 - .15
Lead:			
White, basic carbonate, dry casks, lb.	.07½-	.07½-	.07½-
White, basic sulphate, sck., lb	.07 -	.07 -	.07½-
Red, dry, sck., lb.	.07½-	.07½-	.09 -
Lead acetate, white crys., bbl., lb	.11 - .12	.11 - .12	.13 - .13½
Lead arsenate, powd., bbl., lb.	.10 - .14	.11 - .14	.13 - .14
Lime, chem., bulk, ton	8.50 -	8.50 -	8.50 -
Litharge, pwd., csk, lb.	.06½-	.06½-	.08 -
Lithopone, bags, lb.	.04½- .05	.04½- .05	.05½- .06½
Magnesium carb., tech., bags, lb.	.06 - .06½	.06 - .06½	.06 - .06½
Methanol, 95%, tanks, gal.	.33 -	.33 -	.38 -
97%, tanks, gal.	.34 -	.34 -	.39 -
Synthetic, tanks, gal.	.37½-	.37½-	.40½- .45
Nickel salt, double, bbl., lb.	.10½- .11	.10½- .11	.13 - .13½
Single, bbl., lb.	.10½- .11	.10½- .11	.13 - .13½
Orange mineral, csk., lb.	.09½-	.09½-	.11 -
Phosphorus, red, cases, lb.	.42 - .44	.42 - .44	.42 - .44
Yellow, cases, lb.	.31 - .32	.31 - .32	.31 - .32
Potassium bichromate, casks, lb	.09 - .09½	.09 - .09½	.09 - .09½
Carbonate, 80-85%, calc., csk., lb	.05½- .06	.05½- .06	.05½- .06
Chlorate, powd., lb.	.08 - .08½	.08 - .08½	.08½- .09
Cyanide, cs., lb.	.55 - .57	.55 - .57	.52 - .55
First sorts, csk., lb.	.08½- .09	.08½- .09	.08½- .09
Hydroxide (c'stic potash) dr., lb	.06½- .06½	.06½- .06½	.06½- .06½
Muriate, 80% bgs., ton	37.15 -	37.15 -	37.15 -
Nitrate, bbl., lb.	.05½- .06	.05½- .06	.06 - .07½
Permanganate, drums, lb.	.16 - .16½	.16 - .16½	.16 - .16½
Prussiate, yellow, casks, lb.	.18½- .19½	.18½- .19	.18½- .19
Sal ammoniac, white, casks, lb	.04½- .05	.04½- .05	.04?- .05
Salsoda, bbl., cwt.	.90 - .95	.90 - .95	.90 - .95
Salt cake, bulk, ton	15.00 -18.00	15.00 -18.00	20.00 -22.00
Soda ash, light, 58%, bags, contract, cwt.	1.15 -	1.15 -	1.32 -
Dense, bags, cwt.	1.17½-	1.17½-	1.35 -
Soda, caustic, 76%, solid, drums, contract, cwt.	2.50 - 2.75	2.50 - 2.75	2.90 - 3.00
Acetate, works, bbl., lb.	.05 - .05½	.04½- .05	.04 - .05
Bicarbonate, bbl., cwt.	1.85 - 2.00	1.85 - 2.00	2.00 - 2.25
Bichromate, casks, lb.	.07 - .07½	.07 - .07½	.07 - .07½
Bisulphate, bulk, ton	14.00 -16.00	14.00 -16.00	14.00 -16.00
Bisulphite, bbl., lb.	.03½- .04	.03½- .04	.03½- .04
Chlorate, kegs, lb.	.05½- .07½	.05½- .07½	.07 - .08
Chloride, tech., ton	12.00 -14.75	12.00- 14.75	12.00 -14.00
Cyanide, cases, dom., lb.	.16½- .17	.16½- .17	.18½- .22
Fluoride, bbl., lb.	.08 - .08½	.08 - .08½	.08 - .09
Hyposulphite, bbl., lb.	2.40 - 2.50	2.40 - 2.50	2.40 - 2.50
Nitrate, bags, cwt.	2.05 -	2.05 -	2.10 -
Nitrite, casks, lb.	.07½- .08	.07½- .08	.07½- .08
Phosphate, dibasic, bbl., lb.	.0265 - .03	.0265- .03	.03½- .03½
Prussiate, yel. drums, lb.	.11½- .12	.11½- .12	.11½- .12
Silicate (30°, drums), cwt.	.60 - .70	.60 - .70	.60 - .70
Sulphide, fused, 60-62%, dr., lb.	.02½- .03½	.02½- .03	.03½- .04
Sulphite, cyrs., bbl., lb.	.03 - .03½	.03 - .03½	.02 - .03
Sulphur, crude at mine, bulk, ton	18.00 -	18.00 -	18.00 -
Chloride, dr., lb.	.05 - .06	.05 - .06	.05 - .06
Dioxide, cyl., lb.	.06½- .07	.06½- .07	.07 - .08
Flour, bag, cwt.	1.55 - 3.00	1.55 - 3.00	1.55 - 3.00
Tin bichloride, bbl., lb.	nom. -	nom. -	nom. -
Oxide, bbl., lb.	.25 -	.26 -	.40 -
Crystals, bbl., lb.	.24 -	.24 -	.27½-
Zinc chloride, gran., bbl., lb.	.06½- .06½	.06½- .06½	.06½- .06½
Carbonate, bbl., lb.	.10½- .11	.10½- .11	.10 - .11
Cyanide, dr., lb.	.41 - .42	.41 - .42	.40 - .41
Dust, bbl., lb.	.05½- .06	.05½- .06	.07½- .08
Zinc oxide, lead free, bag, lb.	.06½-	.06½-	.06½-
5% lead sulphate, bags, lb.	.06½-	.06½-	.06½-
Sulphate, bbl., cwt.	3.00 - 3.25	3.00 - 3.25	2.75 - 3.00

Oils and Fats

	Current Price	Last Month	Last Year
Castor oil, No. 3, bbl., lb.	$0.10½-$0.11	$0.10½-$0.11	$0.12 -$0.13
Chinawood oil, bbl., lb.	.06½-	.06½-	.09½-
Coconut oil, Ceylon, tanks, N.Y., lb.	.04½-	.04½-	.06½
Corn oil crude, tanks, (f.o.b. mill), lb.	.07½-	.07½-	.07½-
Cottonseed oil, crude (f.o.b. mill), tanks, lb.	.06 -	.06½-	.07 -
Linseed oil, raw, car lots, bbl., lb.	.087-	.09 -	.141-
Palm, Lagos, casks, lb.	.05 -	.05 -	.07 -
Niger, casks, lb.	.04½-	.04½	.06½-
Palm Kernel, bbl., lb.	.05 -	.05½	.07½-
Peanut oil, crude, tanks (mill), lb.	.07 -	.07 -	.07½-
Rapeseed oil, refined, bbl., gal.	.44 - .46	.46 - .48	.70 - .72
Soya bean, tank (f.o.b. Coast), lb.	nom. -	nom. -	.09½-
Sulphur (olive foots), bbl., lb.	.05½-	.05½-	.07½-
Cod, Newfoundland, bbl., gal.	.40 - .44	.42 - .45	.55 - .57
Menhaden, light pressed, bbl., gal	.34 - .36	.34 - .36	.63 - .65
Crude, tanks (f.o.b. factory), gal.	.20 -	nom. -	nom. -
Whale, crude, tanks, gal.	nom. -	.78 -	- .80
Grease, yellow, loose, lb.	.02½-	.03 -	.04½-
Oleo stearine, lb.	.06½-	.07½-	.08½
Red oil, distilled, d.p. bbl., lb	.08½-	.08½-	.10½
Tallow, extra, loose, lb.	.03 -	.03½-	.05¼

Coal-Tar Products

	Current Price	Last Month	Last Year
Alpha-naphthol, crude, bbl., lb.	$0.60 -$0.65	$0.60 -$0.65	$0.60 -$0.62
Refined, bbl., lb.	.80 - .85	.80 - .85	.80 - .85
Alpha-naphthylamine, bbl., lb.	.32 - .34	.32 - .34	.32 - .34
Aniline oil, drums, extra, lb.	.14½- .15	.14½- .15	.15 - .16
Aniline salts, bbl., lb.	.24 - .25	.24 - .25	.24 - .52

Coal-Tar Products (Continued)

	Current Price	Last Month	Last Year
Benzaldehyde, U.S.P., dr., lb.	1.10 - 1.25	1.10 - 1.25	1.15 - 1.25
Benzidine base, bbl., lb.	.65 - .67	.65 - .67	.65 - .67
Benzoic acid, U.S.P., kgs, lb.	.48 - .52	.48 - .52	.57 - .60
Benzyl chloride, tech., dr., lb.	.30 - .35	.30 - .35	.30 - .35
Benzol, 90%, tanks, works, gal.	.19 - .20	.20 - .21	.21 - .22
Beta-naphthol, tech., drums, lb.	.22 - .24	.22 - .24	.22 - .24
Cresol, U.S.P., dr., lb.	.13 - .17	.14 - .17	.14 - .17
Cresylic acid, 97%, dr., wks., gal.	.54 - .58	.54 - .58	.60 - .70
Diethylaniline, dr., lb.	.55 - .58	.55 - .58	.55 - .58
Dinitrophenol, bbl., lb.	.29 - .30	.29 - .30	.30 - .31
Dinitrotoleun, bbl., lb.	.16 - .17	.16 - .17	.16 - .17
Dip oil, 25% dr., gal.	.26 - .28	.26 - .28	.26 - .28
Diphenylamine, bbl., lb.	.38 - .40	.38 - .40	.39 - .40
H-acid, bbl., lb.	.65 - .70	.65 - .70	.68 - .70
Naphthalene, flake, bbl., lb.	.03½- .04½	.03½- .04½	.04½ - .05
Nitrobenzene, dr., lb.	.08½- .09	.08½- .09	.08½- .10
Para-nitraniline, bbl., lb.	.51 - .55	.51 - .55	.51 - .55
Para-nitrotoluine, bbl., lb.	.29 - .30	.29 - .31	.29 - .31
Phenol, U.S.P., drums, lb.	.14½- .15	.14½- .15	.14½- .15
Picric acid, bbl., lb.	.30 - .40	.30 - .40	.30 - .40
Pyridine, dr., lb.	1.50 - 1.75	1.50 - 1.80	1.50 - 1.80
R-salt, bbl., lb.	.40 - .44	.40 - .44	.44 - .45
Resorcinal, tech., kegs, lb.	1.15 - 1.25	1.15 - 1.25	1.15 - 1.25
Salicylic acid, tech., bbl., lb.	.33 - .35	.33 - .35	.33 - .35
Solvent naphtha, w.w., tanks, gal	.25 - .30	.25 -.....	.28 - .30
Tolidine, bbl., lb.	.86 - .88	.86 - .88	.91 - .93
Toluene, tanks, works, gal.	.29 -.....	.30 -.....	.35 -.....
Xylene, com., tanks, gal.	.25 - .28	.25 - .28	.28 - .30

Miscellaneous

	Current Price	Last Month	Last Year
Barytes, grd., white, bbl., ton	$23.00-$25.00	$23.00-$25.00	$23.00-$25.00
Casein, tech., bbl., lb.	.07 - .11	.07½- .11	.13½- .16
China clay, dom., f.o.b. mine, ton	8.00 -20.00	8.00 -20.00	8.00 -20.00
Dry colors:			
Carbon gas, black (wks.), lb.	.03 - .20	.03 - .20	.05 - .22
Prussian blue, bbl., lb.	.35 - .36	.35 - .36	.35 - .36
Ultramine blue, bbl., lb.	.06 - .32	.06 - .32	.03 - .35
Chrome green, bbl., lb.	.27 - .28	.27 - .28	.27 - .30
Carmine red, tins, lb.	5.00 - 5.40	5.00 - 5.40	6.00 - 6.50
Para toner, lb.	.75 - .80	.75 - .80	.77 - .80
Vermilion, English, bbl., lb.	1.65 - 1.70	1.70 - 1.80	1.90 - 2.00
Chrome yellow, C. P., bbl., lb.	.16½- .17	.16½- .17	.17 - .17½
Feldspar, No. 1 (f.o.b. N.C.), ton	6.50 - 7.50	6.50 - 7.50	6.50 - 7.50
Graphite, Ceylon, lump, bbl., lb.	.07 - .08½	.07 - .08½	.04 - .05
Cum copal Congo, bags, lb.	.06 - .08	.06 - .08	.07½- .08
Manila, bags, lb.	.16 - .17	.16 - .17	.16 - .17
Damar, Batavia, cases, lb.	.16 - .16½	.16 - .19	.18 - .19
Kauri No. 1 cases, lb.	.45 - .48	.45 - .48	.48 - .53
Kieselguhr (f.o.b. N. Y.), ton	50.00 -55.00	50.00 -55.00	50.00 -55.00
Magnesite, calc, ton	40.00 -.....	40.00 -.....	40.00 -.....
Pumice stone, lump, bbl., lb.	.05 - .07	.05 - .08	.05 - .07
Imported, casks, lb.	.03 - .40	.03 - .40	.03 - .35
Rosin, H., bbl.	6.50 -.....	6.35 -.....	6.90 -.....
Turpentine, gal.	.56 -	.55½-.....	.47 -.....
Shellac, orange, fine, bags, lb.	.38 - .40	.38 - .40	.50 - .52
Bleached, bonedry, bags, lb.	.30 - .31	.30 - .31	.36 - .37
T. N. bags, lb.	.16 - .17	.16 - .17	.27 - .28
Soapstone (f.o.b. Vt.), bags, ton	10.00 -12.00	10.00 -12.00	10.00 -12.00
Talc, 200 mesh (f.o.b. Vt.), ton	8.00 - 8.50	8.00 - 8.50	9.50 -.....
300 mesh (f.o.b. Ga.), ton	7.50 -10.00	7.50 -10.00	7.50 -11.00
225 mesh (f.o.b. N. Y.), ton	13.75 -.....	13.75 -.....	13.75 -.....

	Current Price	Last Month	Last Year
Wax, Bayberry, bbl., lb.	$0.19½-$0.22	$0.20 -$0.22	$0.23 -$0.25
Beeswax, ref., light, lb.	.27 - .28	.28 - .30	.34 - .37
Candelilla, bags, lb.	.14½- .15	.14½- .15	.19 - .20
Carnauba, No. 1, bags, lb.	.37 - .40	nom.-.....	.30 - .32
Paraffine, crude			
105-110 m.p., lb.	.03¼- .03¾	.03¼- .03¾	.04¼- .05

Ferro-Alloys

	Current Price	Last Month	Last Year
Ferrotitanium, 15-18%, ton	$200.00-.....	$200.00-.....	$200.00-.....
Ferromanganese, 78-82%, ton	80.00-85.00	80.00-85.00	94.00-99.00
Ferrochrome, 65-70%	.11-	.....	.....
Spiegeleisen, 19-21%, ton	30.00-.....	30.00-.....	33.00-.....
Ferrosilicon, 14-17%, ton	39.00-.....	39.00-.....	45.00-.....
Ferrotungsten, 70-80%, lb.	1.10-.....	1.10-.....	1.45-.....
Ferrovanadium, 30-40%, lb.	3.15- 3.50	3.15- 3.50	3.15-3.50

Non-Ferrous Metals

	Current Price	Last Month	Last Year
Copper, electrolytic, lb.	$0.08 -.....	$0.09 -.....	$0.12½-.....
Aluminum, 96-99%, lb.	.233.....	.233.....	.24 - .25
Antimony, Chin. and Jap., lb.	.063.....	.06½-	.07½-.....
Nickel, 99%, lb.	.35 -.....	.35 -.....	.35 -.....
Monel metal, blocks, lb.	.28 -.....	.28 -.....	.28 -.....
Tin, 5-ton lots, Straits, lb.	.22½-.....	.22½-.....	.31½-.....
Lead, New York, spot, lb.	.03½-.....	.03½-.....	.055 -.....
Zinc, New York, spot, lb.	.036-.....	.036 -.....	.0485-.....
Silver, commercial, oz.	.26½.....	.28 -.....	.42½-.....
Cadmium, lb.	.55 -.....	.55 -.....	.70 -.....
Bismuth, ton lots, lb.	1.50 -	1.40 -.....	1.70 -.....
Cobalt, lb.	2.50 -	2.50 -.....	2.50 -.....
Magnesium, ingots, 99%, lb.	.48 -.....	.48 -.....	.85 - 1.10
Platinum, ref., oz.	27.50	23.00	46.00 .....
Palladium ref., oz.	19.00- 21.00	19.00 21.00	26.00-28.00
Mercury, flask, 75 lb.	100.00 -	101.00	120.00 .....
Tungsten powder, lb.	1.65-.....	1.65	1.70- 1.75

Ores and Semi-finished Products

	Current Price	Last Month	Last Year
Bauxite, crushed, wks., ton	$6.50- $8.25	$6.50- $8.25	$7.50 $8.00
Chrome ore, c.f. post, ton	19.00- 24.00	19.00- 24.00	21.50 25.00
Coke, fdry., f.o.b. ovens, ton	2.75- 2.85	2.75- 3.85	2.75- 2.85
Fluorspar, gravel, f.o.b. Ill., ton	17.25- 20.00	17.25- 20.00	18.00- 20.00
Manganese ore, 50% Mn., c.i.f. Atlantic Ports, unit	.24 - .25	.24 - .25	.31 - .36
Molybdenite, 85% MoS_2 per lb. MoS_2, N. Y., lb.	.35 - .40	.35 - .40	.48- .50
Monazite, 6% of ThO_2, ton	60.00 -.....	60.00 -.....	60.00-.....
Pyrites, Span. fines, c.i.f., unit	.13 -.....	.13 -.....	.13 -.....
Rutile, 94-96% TiO_2, lb.	.10 - .11	.10 - .11	.10 - .11
Tungsten, scheelite, 60% WO_3 and over, unit	11.50 - 12.00	11.25 -11.50	15.25 -16.50

CURRENT INDUSTRIAL DEVELOPMENTS

New Construction and Machinery Requirements

Alkali Mill—Diamond Alkali Co., Fairport Harbor, O., has started foundation work on a 1 story, 90 x 230 ft. mill. Estimated cost $100,000. Private plans.

Ammunition Magazines, etc.—U. S. Property & Disbursing Officer, 128 State Capitol, Sacramento, Calif., will receive bids until June 24 for the construction of three ammunition magazines, three storehouses, twenty-seven feed racks, etc., at National Guard Training Camp, San Luis Obispo.

Ammunition Magazine, etc.—U. S. Army, Air Corps., F. B. Lees, Constructing Quartermaster, Wright Field, Dayton, O., will receive bids until June 25 for the construction of a group of buildings, including ammunition magazine, oil house, radio beacon building, dynamometer storage building and maintenance building at Wright Field. Estimated cost $225,000.

Asbestos Mill—G. W. Land c/o University of Chicago, Chicago, Ill., H. Noll and R. L. Schmerbeck, Kerrville, Tex., are having tentative plans prepared for the construction of a mill to manufacture raw product into market channels at Fredericksburg.

Plant—Rockbestos Products Corp., 285 Nicoll St., New Haven, Conn., plans the construction of a plant for the manufacture of electric equipment at Montreal, Que.

Brass and Copper Products Plant—H. M. Hillman, 188 Flatbush Ave. Ext., Brooklyn, N. Y. (manufacturers of brass and copper products), plans the construction of a plant and storage building at Flatbush Ave. Ext. and Myrtle Ave. Estimated cost to exceed $40,000 including equipment. Erling Owre, 53 Fort Hill Circle, St. George, S. I.

Carbon Plant — Continental Carbon Inc., 13900 Lorain Ave., Cleveland, O., manufacturers of radio resisters and carbon specialties, plans the construction of a plant at Toronto, Ont.

Cellulose Plant — Sylvania Industrial Corp., Fredericksburg, Va., awarded contract for addition to plant for the manufacture of transparent wrapping paper made from cellulose, to Hughes-Foulkrod Co., Schaff Bldg., Philadelphia, Pa. Estimated cost $1,000,000.

Alum Building — Merrimac Chemical Co., Chemical Lane, Everett, Mass., is receiving bids for a 1 story alum process building, including concrete tanks. Estimated cost $40,000. Private plans.

Bi-Sulphite Building—Merrimac Chemical Co., Everett, Mass., awarded contract for the construction of a 2 story, 80 x 100 ft. bi-sulphite building at Chemical Lane to J. F. Grifin Co., 250 Stuart St., Boston. Estimated cost $50,000.

Chemical Plant—Clifton Chemical Co. Inc., 246 Front St., New York, N. Y., postponed construction of 2 story chemical plant at 64-68 Essex St. Estimated cost $40,000. Maturity about December.

Chemical Plant — Naugatuck Chemical Co., Nagatuck, Conn., plans rebuilding plant damaged by explosion. Conveying equipment will probably be required.

Boll Weevil Poison Plant—M. T. Khorn, L. Salinas, and R. R. Mungia, Matomoros, Mexico, plan the construction of a plant for the manufacture of a new boll weevil poison, including machinery to disseminate the poison.

Dye Works—Passaic Pierce Dye Works, 420 Bloomfield Ave., Passaic, N. J., will build a 2 story, 50 x 70 ft. addition to dye works on Bloomfield Ave. Estimated cost $40,000. J. F. Kelly, Post Office Bldg., Passaic, is architect. Work will be done by separate contracts.

Plant—Collins Flashlight Corp., Fredericksburg, Va., C. B. Collins, Takoma Park, Md., Pres., recently organized with capital stock of $1,000,000, plans establishment of a plant for the manufacture of batteryless flashlights.

Plant—City of Winnipeg, Man., R. H. Webb, Mayor plans the construction of a concentration plant for manganese ores. Initial cost $250,000.

Enameling Furnace—Mullins Mfg. Co., Salem, O., plans the construction of a new continuous electrical porcelain enameling furnace including new press equipment, sand blasting units, mill equipment for enameling, complete conveyor apparatus for production line and various welding devices. Estimated cost $175,000.

Metal Stamping and Enamelware Factory—Geuder, Paeschke & Frey Co., 38 15th St., Milwaukee, Wis., manufacturers of metal stampings and enamelware, awarded contract for a 1 story, 60 x 138 ft. addition to factory to Meredith Bros., 121 East Washington St., Milwaukee.

Gas Plant—Central Hudson Gas & Electric Corp., 80 Market St., Poughkeepsie, N. Y., has been granted franchise by Public Service Commission for installation of a butane air gas plant in Cold Spring. Estimated cost $23,000.

Gas Plant—Iowa Railway & Light Co., Cedar Rapids, Ia., plans the installation of an artificial gas plant at Tama. Estimated cost $60,000.

Gas Plant—New York Power & Light Corp., subsidiary of Niagara Hudson Power Corp., 15 Broad St., New York, N. Y., has been granted franchise by Public Service Commission for the construction of a butaine air gas plant, two units, each 200,000 cu.ft. of gas per day at Canajoharie. Estimated cost $25,000.

Gas Plant—Rio Grande Public Service Co., c/o F. A. Hornaday, 709 Maverick Bldg., San Antonio, Tex., will build a gas plant at Rio Grande City, also 20½ mi. pipe line from field to city and distribution lines within city limits. Estimated cost $110,000. Work will be done by owners forces. Machinery contracts let.

Gas Manufacturing Plant—Coos Gas Co., O. J. Coulombe, Pres., Berlin, N. H., plans the construction of a plant. Estimated cost $40,000. Architect not selected.

Gypsum Factory—Canadian Gypsum Co., H. O. 1221 Bay St., Toronto, Ont., awarded contract for the construction of a factory including 56 x 300 ft. sheet rock building, 50 x 156 ft. mill, 40 x 42 ft., machine shop, 50 x 175 ft. warehouse to W. H. Cooper, Lister Bldg., Hamilton.

Health Building—S. Levy, Pres. Borough of Manhattan, New York, will receive bids late in June for the construction of an 11 story building to house city departments of Health, Hospitals, Sanitation and Medical Examiner including laboratories at Worth, Centre, Leonard and Lafayette Sts. Estimated total cost $4,720,000.

Kiln Building—Saginaw Malleable Iron Co., Division of General Motors Corp., General Motors Bldg., Detroit, Mich., awarded contract for a 1 story, 80 x 512 ft. kiln building at Saginaw to Austin Co., 16112 Euclid Ave., Cleveland, O. Estimated cost $500,000.

Laboratory — California Institute of Technology, Pasadena, Calif., awarded contract for the construction of a laboratory on East California St. to W. C. Crowell, 495 South Broadway, Los Angeles. Estimated cost $150,000.

Laboratory—Bd. of Trustees, Suffield School, Suffield, Conn., is having preliminary plans prepared for the construction of a school including laboratory, etc. Estimated cost $1,000,000. J. G. Rogers, 154 East 56th St., New York, N. Y., is architect.

Laboratory—Montefiore Hospital, Gunhill Rd., New York, N. Y., postponed construction of a hospital, including laboratory. $1,000,000. Kohn & Butler, 56 West 45th St., New York, are architects. Project in abeyance until late 1932.

Laboratory (Biological)—Dept. of Health, 505 Pearl St., New York, N. Y., will receive bids latter part of July for the construction of a biological laboratory on 16th St. Estimated cost $500,000. Sibley & Fetherstone, 205 West 42nd St., New York, are architects.

Laboratory (Science) — Bd. of Trustees, Knoxville College, Knoxville, Tenn., plans the construction of a science laboratory. Estimated cost $100,000.

Laboratories—First District Arkansas Agricultural & Mechanical College, V. C. Kays, Pres., Jonesboro, Ark., will receive bids about July 1 for the construction of a 4 story, 145 x 206 ft. administration building including laboratories, etc. Estimated cost $250,000. Petter & McAninch, Pyramid Life Bldg., Little Rock and E. W. Mann, Cotton Exchange Bldg., Memphis, Tenn., are associate architects.

Laboratories—School District No. 1, Arkadelphia, Ark., will receive bids until July 7 for the construction of a 3 story, 135 x 206 ft. high school including science laboratories, etc. Estimated cost $140,000. Petter & McAninch, Pyramid Life Bldg., Little Rock, are architects.

Laboratories (Physics and Chemistry)—Collegiate Institute, Woodstock, Ont., awarded contract for a 3 story, 80 x 120 ft. addition to physics and chemistry laboratories to Stuart Bros., 15 Hyde Park Ave., Hamilton. Estimated cost $161,000.

University Building—State Dept. of Education, Albany, N. Y., received lowest bid for the construction of school of ceramics, also service connections (tunnels) at Alfred University, Alfred, from Havens Construction Co., Olean, $109,000.

Lead and Zinc Mill—Eagle-Picher Lead Co., Picher, Okla., is having preliminary plans the construction of a new lead and zinc concentration mill, 3,600-ton daily capacity. Estimated cost $400,000. Private plans.

Paper Plant — De Pere Paper Mfg. Co., H. Miller, Mgr., Fort Howard Ave., De Pere, Wis., plans to rebuild plant recently destroyed by fire.

Plant — Taunton Pearl Works, 35 Vernon St., Taunton, Mass., will soon award contract for the construction of a 2 story manufacturing plant. Estimated cost $50,000. Jackson & Moreland, 31 St. James Ave., Boston, are architects.

Polish Plant—Sunshine Products of Canada, Ltd., T. H. H. Orr, Pres., Guelph, Ont., plans the construction of a plant for the manufacture of liquid wax polishes, oils, etc. Estimated cost $50,000.

Pottery Plant — Harker Pottery Co., East Liverpool, O., awarded contract for the construction of a 200 ft. tunnel kiln at Chester, W. Va., to Harrop Ceramic Service Co., 310 West Broad St., Columbus, O., also 1 story, 140 x 200 ft. factory to house new tunnel kiln at Chester to Finley Bros. Lumber Co., Chester. Estimated cost $100,000 and $50,000 respectively.

Pottery Plant—Edwin M. Knowles China Co., Newell, W. Va., awarded contract for a 300 ft. tunnel kiln to Harrop Ceramic Service Co., 310 West Broad St., Columbus, O., also 1 story factory to house new kiln to Potters Lumber Co., East Liverpool, O. Estimated cost $100,000 and $100,000 respectively.

Rayon Factory—Princeton Rayons Inc., 150 Madison Ave., New York, N. Y., is having preliminary plans prepared for the construction of a factory at Scranton, Pa. Estimated cost $300,000.

Oil Storage and Distribution Plant—Quaker State Oil Refining Co., 654 East 60th St., Los Angeles, Calif., plans the construction of an oil storage and distribution plant on East 12th St., Oakland. Estimated cost to exceed $100,000. J. E. McCormick, in charge.

Refinery—Shell Petroleum Co., City National Bank Bldg., San Antonio, Tex., acquired properties of Seaboard Gasoline & Refining Co. in Panhandle and plans enlargements, replacement of machinery and equipment, etc.

Refinery — Pennsylvania Refinery Co. (Canada) Ltd., Hamilton, Ont., plans the construction of a refinery. Initial cost $100,000.

Refinery (Oil)—Alleghany Refineries Inc. is being organized by W. E. Sawyer & Associates, Bolivar, N. Y., with capital of $500,000, plans the construction of an oil refinery 500 bbl. capacity. Initial cost to exceed $200,000.

Refinery (Oil) — Dean Lewis & Associates, Mineola, Tex., acquired a site and plans the construction of an oil refinery. Estimated cost $125,000. Complete equipment will be required.

Refinery (Oil)—Houston Oil Co., Petroleum Bldg., Houston, Tex., will soon award contract for enlargement of present refinery including several large steel retaining (storage) tanks, additional equipment for refining, etc. Estimated cost $1,000,000. Private plans.

Refinery (Oil)—Master Petroleum Co., S. J. T. Smith, Pres., Waco, Tex., is having plans prepared for the construction of an oil refinery at East Waco. Estimated cost $100,000 including equipment.

Refinery (Oil)—E. W. Moutray, Abilene, Tex., ready to build 1,000 bbl. oil refinery near Hawley. Estimated cost $80,000. Private plans. Owner is in the market for machinery and equipment.

Refinery (Oil)—Owner, c/o W. W. Tapp, Jr., Starks Bldg., Louisville, Ky., plans the construction of an oil refinery, 20,000 bbl. of crude oil daily capacity at Owensboro. Estimated cost $110,000. Engineer not announced.

Refining Equipment — Distillazione Italiana Combustibles, S. A. Venice, Italy, awarded contract for process petroleum refining equipment to Arthur G. McKee Co., 2422 Euclid Ave., Cleveland, O.

Rubber Factory—Rand Rubber Co., Halsey St. and Sumner Ave., Brooklyn, N. Y., is having sketches made for addition and alterations to factory. Estimated cost $40,000 including equipment. M. Marlo, 100 Beverly Rd., Brooklyn, is architect.

Rubber Stamp Factory—Fulton Specialty Co., 128 Fulton St., Elizabeth, N. J., will not make alterations to plant. $40,000. Project abandoned.

INDUSTRIAL NOTES

ABBE ENGINEERING & BEACH RUSS COMPANIES of 50 Church Street, New York, have moved into larger quarters at the same address.

TURBO-MIXER CORPORATION, New York, has appointed the National Supply Company as representative for the petroleum industry in the southwest.

ROBERT CRAMER has moved his consulting engineering office to 647 West Virginia St., Milwaukee, Wis.

SHARPLES SPECIALTY COMPANY, Philadelphia, has appointedWeaver L. Marston sales manager with headquarters at the main office at 23rd and Westmoreland Streets.

BOILER ENGINEERING COMPANY has moved into more capacious quarters at 744 Broad Street, Newark, N. J.

CUTLER-HAMMER, INC., has moved its Atlanta, Ga., office to 133 Cone St.

HARDINGE COMPANY, York, Pa., has opened new offices at 205 W. Wacker Drive, Chicago, under C. W. Ankeny and at 235 Montgomery St., San Francisco, under W. L. Penick.

NEILAN COMPANY, LTD., Los Angeles, Calif., has opened a branch office at 1301 Clark Building, Pittsburgh, under Bruce Irwin.

ROMEC PUMP COMPANY is the new name of the Martell Packings Co., Elyria, Ohio.

PYROMETER SERVICE AND SUPPLY CORPORATION, Cleveland, Ohio, has appointed G. F. Newell vice-president and general manager.

COLVULC RUBBER COMPANY is the new name of the Hitchcock Co., Inc., Boston, Mass., and is now located at Norfolk Downs, Mass.

HUNGERFORD & TERRY, INC., Clayton, N. J. has appointed H. R. Myers to take charge of the Boston office to replace D. R. Weedon.

PFAUDLER COMPANY, Rochester, N. Y., has made new appointments as follows: H. S. Calvert, executive vice-president in charge of sales developments; George F. Kroha, vice-president and general sales manager; George C. Calvert, assistant general sales manager; R. Miner, foreign sales director; Philip S. Barnes, manager of sales chemical division; and William H. Klee, manager of Midwest sales.

NORTHERN EQUIPMENT COMPANY, Erie, Pa., has appointed Joseph W. Eshelman as representative in an extension of his territory around Alabama.